376

non linear systems, inc.

DEL MAR, CALIFORNIA

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INSTRUCTION MANUAL
SERIES X-2
DIGITAL VOLTMETER

Originator of the Digital Voltmeter
non-linear systems, inc.
DEL MAR, CALIFORNIA

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CAUTION

WHEN THE INSTRUMENT DESCRIBED IN THIS MANUAL IS INSTALLED IN A SERIES X-1-TYPE OUTER CHASSIS (FOR SYSTEM APPLICATION), REMOVE CABLE CONNECTIONS PRIOR TO REMOVING THE INSTRUMENT DRAWER ASSEMBLY FROM THE CHASSIS. FAILURE TO OBSERVE THIS PRECAUTION MAY CAUSE DAMAGE TO CABLE AND INSTRUMENT CONNECTORS.

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" " "D" Change	Decade Assembly
37-36	Reference Assembly
37-39	Attenuator Assembly
37-69	Start/Stop Assembly
37-72	Main Board & Power Supply Assembly
37-105	Main Board & Power Supply Assembly
37-160	Decade Assembly
37-272	Reference Assembly
37-275	Attenuator Assembly
37-298	Main Board Assembly
37-360	Decade Assembly

LIST OF SCHEMATIC DIAGRAMS (CON'T)

Dwg. No.	Title
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37-281	AC/DC Converter Assembly (10K Hz)
37-316	Print Board Assembly

CHAPTER I

INTRODUCTION AND SPECIFICATIONS

The NLS Series X-2 Digital Voltmeter is a three-range, four-digit instrument with automatic polarity and with provisions for 20% over-ranging on the two lowest ranges. An automatic ranging feature is offered as an option. The instrument may be used as a bench model or, with the use of rack-mounting adapters, may be rack-mounted in a standard 19-inch mounting rack.

OPTIONAL FUNCTION ACCESSORIES

In addition to measuring DC voltages, the Series X-2 DVM is capable of measuring AC voltages, millivolts and ohms. These extra features may be obtained by utilizing optional plug-in modules. A K Ohms converter/pre-amplifier provides ohms and millivolt measurements or a precision pre-amplifier provides higher accuracy in millivolt measurements, and one of two types of AC converters (50 Hz to 10K Hz or 50K Hz to 100K Hz) provides AC voltage measurement.

GENERAL

The Series X-2 Digital Voltmeters are solid state integrating instruments that measure the absolute value of DC voltages or the integral of varying voltages. In these instruments the unknown input voltage is converted to a pulse train whose repitition rate is directly proportional to input voltage magnitude. The total number of pulses generated over a clocked 0.1 second interval is counted electronically and displayed as the voltage value.

OPERATING PRINCIPLE

An input of 10 volts to the instrument creates 10,000 pulses in 0.1 second; this is displayed as 10.000 volts. If the input voltage changes during the measuring interval, the pulse repetition rate changes proportionately, and the total number of pulses that occurs during the 0.1 second sample period is a measure of the number of volt-seconds at the input. Since these instruments mathematically integrate the input voltage, they are useful for obtaining the velocity from a voltage which is proportional to acceleration. In addition, these instruments are inherently able to reject sinusoidal ripple because the integrated value of an integral number of sine waves is zero. Therefore if an integral number of cycles of sine wave noise occurs during the 0.1-second sampling interval, its contribution to the overall reading is "integrated out".

DIGITAL OUTPUT

Beginning with serial number X-2.157, the instrument possesses a printout and remote triggering capability for operation with data printers, tape punches, typewriters and other recording devices. For printout, the Print Board Assembly, with pendant cable and connector is offered as an option.

FLOATING INPUT

Because input signal leads may be disconnected from the Series X-2's outer chassis (by removing a shorting strap between J5 and J6 on the rear of the instrument), signal-to-chassis potentials up to 500 volts are permissible. Floating input adds to the DVM's versaltility by permitting it to measure voltage sources which could not be accurately measured by a non-isolated meter.

COMMON MODE REJECTION

Rejection of common-mode signals, those

caused by AC or DC currents flowing between signal source ground and instrument chassis ground is a feature of the Series X-2 DVM. (To obtain CMR, the shorting strap described in the above paragraph must be removed.) Common-mode signal rejection is important in a wide range of applications - testing complex electrical and electronic systems, in automatic measuring systems, and measuring outputs from thermocouples, strain gages and other transducers where common-mode signals may be many times greater than the measured DC voltage.

PROCEDURE TO DETERMINE CMR

1. Turn the X-2 DVM on and allow 30 minutes for warm-up.

2. Remove shorting strap between J5 and J6.

3. Connect DVM to signal source and common-mode source as shown in Figure 1-1. Signal source is preferably a series string of three or four 1.5V batteries (flashlight cells or 1.3V mercury cells). To obtain an accurate measurement of CMR, the source resistance of the signal source should be less than 10 ohms. The output of a variac, connected as shown in Figure 1-1, will adequately provide the required common-mode source.

4. Set variac to zero volts then advance variac in voltage until a one digit "bobble" is observed in the least significant decade then, back off variac until "bobble" just stops. Measure the variac output with an AC voltmeter and convert to peak-to-peak voltage.

5. To obtain rejection ratio, divide peak-to-peak common voltage by 1 MV.

$$\text{Common-mode rejection radio} = \frac{E_{p-p}}{10^{-3}}$$

$$DB = 20 \log \frac{E_{p-p}}{10^{-3}}$$

$$DB = 20 \log 1,000\ E_{p-p}$$

6. For example, if the common-mode voltage is 3.5V

$$E_{p-p} = 3.5 \times 2.828$$

$$E_{p-p} = 10V \text{ and}$$

$$DB = 20 \log 1,000 \times 10$$

$$DB = 20 \log 10^{4}$$

$$DB = 20 \times 4 = 80$$

Common-mode rejection = 80 DB

The NLS Sales Representative or Engineering Department will be pleased to assist you with specific application problems and, of course, will gladly welcome your comments and suggestions.

SPECIFICATIONS

CIRCUITRY:	All solid state.
ANALOG-TO-DIGITAL CONVERSION:	Bi-polar integrator.
FULL SCALE DC RANGES:	±9.999, ±99.99, ±999.9 with 20% over-range on the two lower ranges.

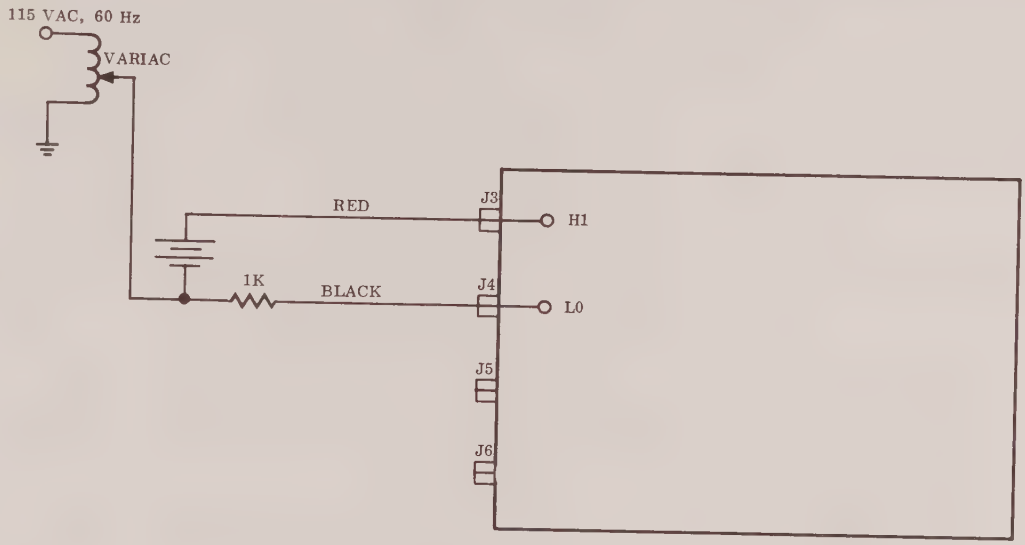


Figure 1-1. Connections to Determine CMR

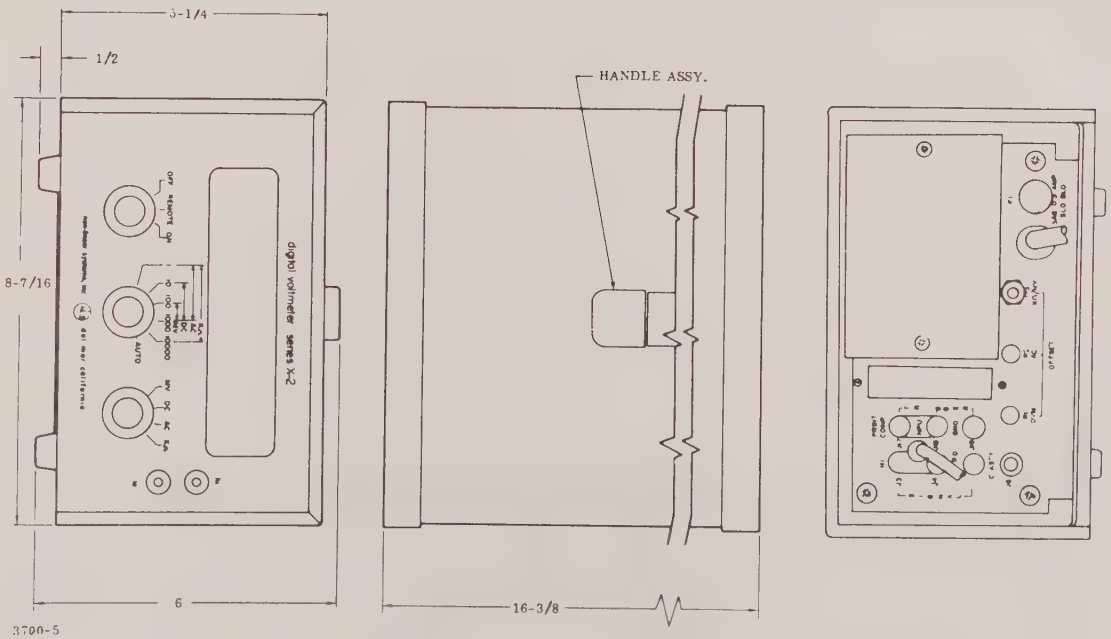


Figure 1-2. Series X-2 DVM Outline Drawing

ACCURACY AT ASA REFERENCE CONDITIONS:	±0.01% of full scale ±0.02% of reading.
RESOLUTION:	One digit.
RESPONSE TIMES:	Voltage-to-Frequency Converter Settling Time - 100 MS (with filter). Digitizing Time - 100 MS. Range Selection Time - 100 MS.
INPUT RESISTANCE:	10 megohms, constant all ranges, except when 20% over-range is exceeded.
COMMON MODE REJECTION:	100 DB @ DC; 80 DB @ 60 Hz -- 1KΩ unbalance
RANGE SELECTION:	Manual or Automatic/Manual (see options).
POLARITY SELECTION:	Automatic.
INPUT CONNECTIONS:	Front and rear. Input may be floated ±500 volts above chassis by removing shorting strap from rear input connectors.
AMBIENT TEMPERATURE:	Extreme - 12° C to 50° C.
POWER REQUIREMENTS:	105/125 VAC, 50/60 Hz.
MOUNTING POSITION:	Any.
WEIGHT:	12 pounds
SIZE:	5-1/4 inches (excluding feet and handle) x 8-7/16 inches x 16-3/8 inches.
OPTIONS AVAILABLE:	Automatic ranging.
ACCESSORIES AVAILABLE:	AC/DC Converters K Ohms/DC Converter and Pre-Amplifier Precision Pre-Amplifier Print Board Assembly - BCD 8-4-2-1 Logic "0" = 0 volt to +0.5 volt, Logic "1" = +3 volts ±0.1 volt Rack Mounting Adapters

AC/DC Converter, Types I and II for X-2

RANGES; including 20% over-range	1.1999/11.999 119.99 & 500.00 VAC
FREQUENCY RESPONSE	10K Hz 100K Hz Lower frequency converters are available on special order. The 10K Hz converter is usable to 30 K Hz in the manual ranging mode.

ACCURACY:	10K Hz	0.05% reading + 0.02% FS, 200 Hz to 3K Hz, 1000 VAC 0.1% reading + 0.05% FS, 50 Hz to 200 Hz and 3K Hz to 10K Hz, 1000 VAC 30 Hz accuracy is typically 0.3%
	100K Hz	Same as 10K Hz, plus: 0.3% reading + 0.1% FS, 10K Hz to 30K Hz, 500 VAC 0.5% reading + 0.1% FS, 30K Hz to 100K Hz, 150 VAC
RESPONSE TIME		600 milliseconds to 0.1% of final value
INPUT IMPEDANCE		One megohm, shunted by 100 PF
RANGING		Automatic and manual

Ohms/DC Converter

ACCURACY	Four Digit	Maximum Current
±0.01% FS and ±0.02% reading (1KΩ, 10KΩ, 100KΩ and 1000K ranges)	1.19999KΩ	10 MA
	11.999KΩ	1 MA
	119.99KΩ	100 μA
	1199.9KΩ	10 μA
±0.01% FS ±0.1%	11,999.KΩ	1 μA

STABILITY	0.05% full scale for at least 90 days on all ranges
RESPONSE TIME	100 milliseconds for step response. 200 milliseconds for step response with range change. 700 milliseconds on 10 megohm range
RANGING	Automatic and manual (Manual only 10,000K Range)
INPUT CONFIGURATION	Two wire with voltage protection

Automatic Ranging DC Preamplifier

RANGES	X10	±000.1 MV to ±1199.9 MV
	X100	±00.01 MV to ±119.99 MV
ACCURACY	X10	±0.02% reading and ±0.01% Full Scale
	X100	±0.05% reading and ±0.05% Full Scale
GAIN STABILITY		0.01% for at least 30 days
ZERO STABILITY		Drift does not exceed ±50 μV or ±5 digits, whichever is greater, for at least seven days at constant temperature.
INPUT INPEDANCE		Greater than 100 megohms
RESPONSE TIME		500 MS for step response to 0.01%

Precision Pre-Amplifier

RANGES:	119.99/1199.9 MVDC
ACCURACY UNDER ASA REFERENCE CONDITIONS:	±(0.01% of reading + 0.01% of full scale)
STABILITY:	Short Term: ±(0.01% of full scale) Long Term: See Rated Accuracy
RESPONSE TIME:	Step to 0.01% of final value: 1 second* Each range change to 0.01% of final value: 1 second*
INPUT CHARACTERISTICS:	Resistance, Steady State: 100 MΩ minimum Resistance, Dynamic: 20 KΩ minimum

* Response time is considerably increased for signals whose source resistance is higher then 10 KΩ.

Specifications are Subject to Change Without Notice

CHAPTER II
INSTALLATION AND OPERATION

UNPACKING

The instrument is shipped in a heavy cardboard container. Cut the tape on the top of the container and open. If damage is seen, promptly notify the carrier.

MOUNTING

The instrument was primarily designed as a bench instrument, however, three types of mounting adapters for mounting in a standard 19-inch mounting rack are available at customer's option. One type may be obtained with an additional drawer for storage of tools, spare parts, etc; a second type will accommodate two Series X-2 DVM's; and the third type is a 19-inch front panel attached to the instrument.

CAUTION

Do not operate the instrument before ensuring that each plug-in board is firmly in place. Failure to take this precaution may cause damage to components on the board assemblies.

POWER SOURCE

Instruments bearing S/N's X-2.1 thru X-2.462 were usually supplied for operation from 110-120 volt, 50-60 Hz, single phase power sources. Instruments bearing S/N's X-2.463 and subsequent operate from 110-120 volts, 50-420 Hz, single phase power sources. All instruments will operate from 220-230 volt sources if the two primaries of the power transformer are wired in series instead of in parallel. The ventilating fan (S/N's X-2.157 thru X-2.462 and others so modified) must be rated at the correct voltage. The Serial No. tag at the rear of the instrument indicates the correct power source if other than 110-120 volts.

FUSING

The instrument is protected by a 3AG one-half ampere fuse which is located in an extractor post on the rear panel. When a 220-230 volt power source is to be used (and the power transformer primary rewired as indicated above), it is recommended that a one-fourth ampere fuse be used to provide maximun protection.

POWER GROUNDING

The third pin of the power plug grounds the outer chassis of the instrument (Figure 2-1). Despite the presence of the third grounding pin, there is no real assurance that the instrument will be correctly connected since the power outlets in many installations are erroneously wired. Be certain that the power source is in agreement with the power and grounding requirements of the instrument.

CONNECTORS (S/N's X-2.1 thru X-2.156)

Two input connectors (J1 and J2, labeled HI and LO respectively) are located on the front panel of the instrument (Figure 2-2) and are wired in parallel with two connectors (J3 and J4) located on the rear of the instrument (Figure 2-3). Two additional connectors (J5 and J6) are located on the rear of the unit and under normal operating conditions are connected together with a shorting strap. To float the input above chassis ground (up to ±500 volts), the shorting strap must be removed.

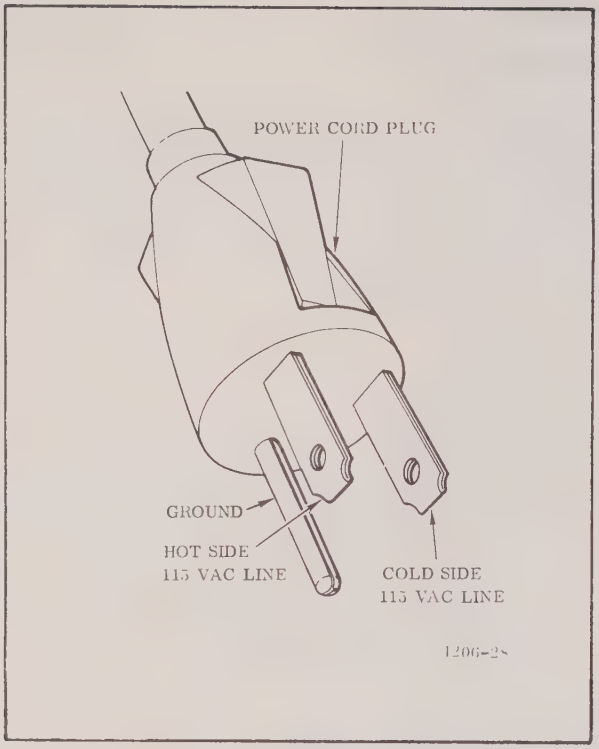


Figure 2-1. Power Plug Pin Coding

CONNECTORS (S/N's X-2.157 & subsequent)

These instruments have the same input connectors as those described in the above paragraph and inaddition, have three remote triggering connectors (J17, J18 and J19) installed on the rear panel. If the printout option is elected, digital output connector J7 is also installed on the rear panel (see Print Board Assembly Schematic Diagram for connector pin information).

CABLE CONNECTIONS

The instrument is supplied with an input cable (P/N 2BC-AL-36) for insertion into J1 and J2 on the front panel or J3 and J4 on the rear panel. See Figure 2-4 for connection information. A mating connector is supplied for J7 when the printout capability option is elected.

CONTROLS

POWER SWITCH (S/N X-2.1 thru X-2.156)

The power switch is located on the front panel of the instrument and has three positions (OFF, STBY. and ON). The STBY. position is used to stop the instrument from taking further readings. The ON position commands the instrument to take readings at its maximum rate (allow 30 minutes for instrument warm-up).

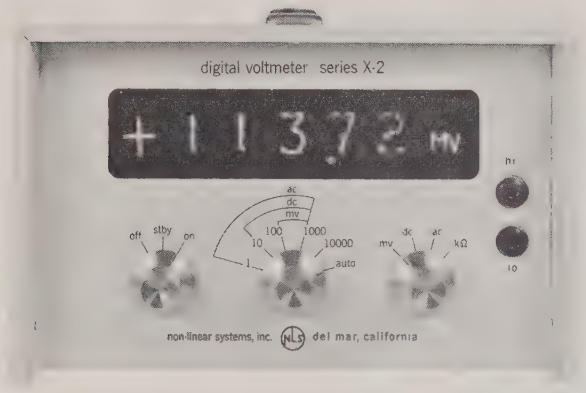
POWER SWITCH (S/N's X-2.157 & subsq.)

The STBY. position of the power switch on these instruments has been re-labeled REMOTE. In the REMOTE position, a print/record pulse is issued at the completion of each measurement; in the ON position this pulse is inhibited. In the absence of a remote triggering pulse, the REMOTE position serves as a standby control, i.e., the last reading taken remains stored in the readout.

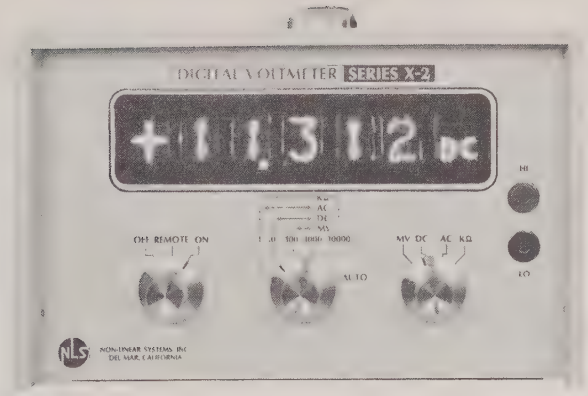
REMOTE TRIGGERING (S/N's X-2.157 & subsequent)

To externally trigger the instrument by a recording device through connector J7, the shorting strap between connectors J17 and J18 must be kept in place. Each pulse applied through connector will provide only a single reading. For each pulse applied, a delay of 180 MS will take place in the VDC, MVDC and K ohms functions and a delay of 900 MS will take place in the AC function.

With the shorting strap between connectors J17 and J18 removed, the instrument may also be externally triggered by a contact closure between connectors J18 and J19. For a single reading only, the duration of this



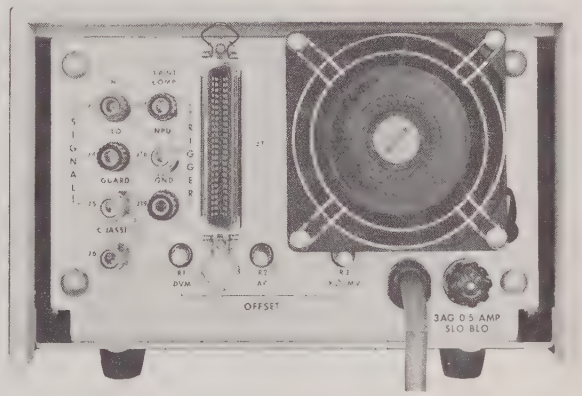
S/N's X-2.1 THRU X-2.156



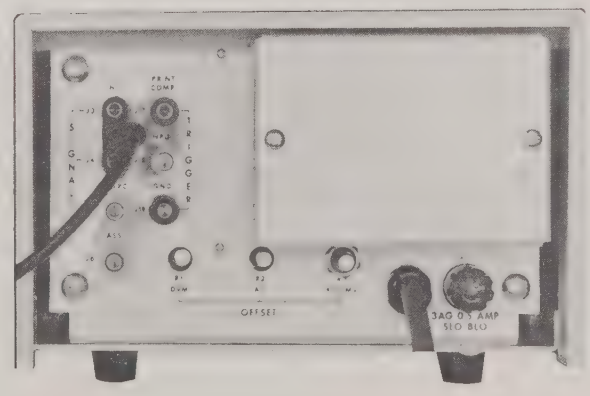
S/N's X-2.157 & SUBSEQUENT

Figure 2-2. Front Views

S/N's X-2.1 THRU X-2.156



S/N's X-2.157 THRU X-2.462



S/N's X-2.463 & SUBSEQUENT

Figure 2-3. Rear Views

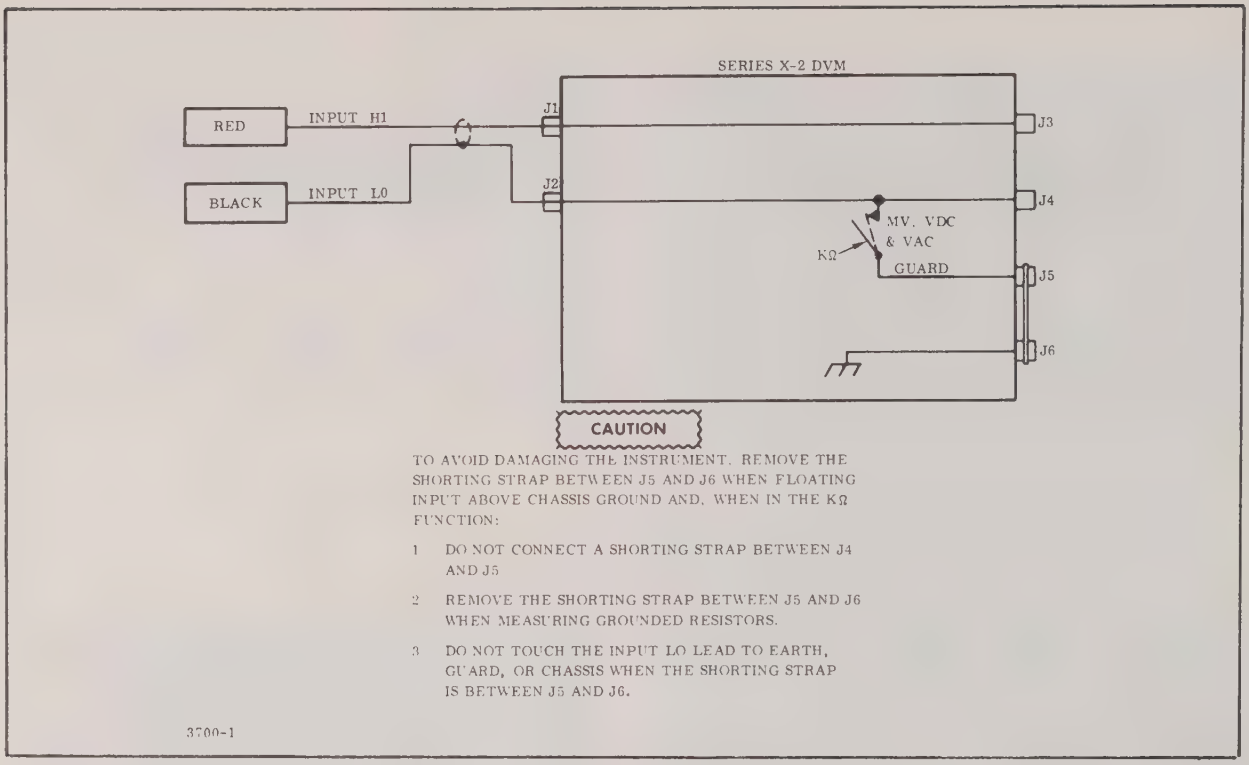

SERIES X-2 DVM
RED
INPUT HI
BLACK
INPUT LO
J1
J2
J3
J4
J5
J6
MV. VDC
& VAC
KΩ
GUARD
CAUTION
TO AVOID DAMAGING THE INSTRUMENT, REMOVE THE SHORTING STRAP BETWEEN J5 AND J6 WHEN FLOATING INPUT ABOVE CHASSIS GROUND AND, WHEN IN THE KΩ FUNCTION:
1 DO NOT CONNECT A SHORTING STRAP BETWEEN J4 AND J5
2 REMOVE THE SHORTING STRAP BETWEEN J5 AND J6 WHEN MEASURING GROUNDED RESISTORS.
3 DO NOT TOUCH THE INPUT LO LEAD TO EARTH, GUARD, OR CHASSIS WHEN THE SHORTING STRAP IS BETWEEN J5 AND J6.
3700-1

Figure 2-4. Input Connections

closure must be less than 100 MS. Closures in excess of 100 MS (with the exception of range changes) will cause the instrument to continuously scan as long as the closure is applied.

To eliminate first-reading-error with either method of triggering, the input signal to be measured must be applied prior to the application of the triggering pulse.

RANGE SWITCH

The range switch is located on the front panel of the instrument and has six positions. (See table I.) When in the 1 position, the instrument is locked in the 1 volt range for the measurement of AC voltages or in the 1K range for the measurement of K ohms. When in the 10 position, the instrument is locked in the 10-volt range for the measurement of AC or DC voltages or in the 10K range for the measurement of K ohms. When in the 100 position, the instrument is locked in the 100-volt range for the measurement of AC and DC voltages, in the 100 MV range for the measurement of millivolts or in the 100K range for the measurement of K ohms. When in the 1000 position, the instrument is locked in the 1000-volt range for the measurement of AC and DC voltages, in the 1000 MV range for the measurement of millivolts or in the 1000KΩ range for the measurement of K ohms. When in the 10,000 position, the instrument is locked in the 10,000KΩ range for the measurement of K ohms. If the instrument has the automatic ranging capability, the proper range is automatically selected when the switch is in the AUTO position. (The 10,000KΩ range can only be selected manually.) With the switch in the AUTO position (if the instrument does not have the auto-ranging capability), the readout will not display decimals and the instrument will be in the lowest range of the particular function selected by the function switch.

OPERATING CAUTIONS

GROUND REFERENCE MEASUREMENTS

When measuring an AC power line, or any potential where one side is reference to earth ground, first remove the shorting strap between guard and chassis ground (J5 and J6) on the rear of the instrument. The guard connects to signal low inside the unit. If signal low (J2) is inadvertently connected to the power line "hot" lead, it will be shorted to ground due to internal circuitry and the instrument will be damaged.

OHMS MEASUREMENT

1. Input low is NOT connected to guard (KΩ mode only). DO NOT therefore connect shorting strap between input low and guard (J4 and J5).
2. If input low lead is allowed to contact earth, guard or chassis with strap between guard and chassis (J5 and J6), fuse on KΩ Converter will blow.

EXTERNAL TRIGGERING

When externally triggering the DVM through pin 47 of connector J7, DO NOT apply an input voltage in excess of 5 volts. Failure to observe this precaution may result in damage to the instrument.

Table I. Measurement Capabilities

Function Switch Positions	Range Switch Positions: 1	10	100	1000	10,000	AUTO
MV	⊠	⊠	100 MV RANGE	1000 MV RANGE	⊠	100 MV or 1000 MV RANGES
DC	⊠	10 VDC RANGE	100 VDC RANGE	1000 VDC RANGE	⊠	10 VDC, 100 VDC, or 1000 VDC RANGES
AC	1 VAC RANGE	10 VAC RANGE	100 VAC RANGE	1000 VAC RANGE (500 VAC MAX.)	⊠	1 VAC, 10 VAC 100 VAC or 1000 VAC RANGES (500 VAC Max)
KΩ	1KΩ RANGE	10KΩ RANGE	100KΩ RANGE	1000KΩ RANGE	10,000KΩ RANGE	ALL EXCEPT 10,000KΩ RNG.

NOTE: The combined positions of the range and function switches as indicated by ⊠ above will produce erroneous readings.

FUNCTION SWITCH

The function switch is located on the front panel of the instrument and has four positions. (See Table I.) It is used to select the desired measurement function, either MV, DC, AC or KΩ.

OFFSET CONTROLS

Three screwdriver-adjust potentiometers are located on the rear of the unit. They are provided to zero the reading of the instrument in each of its measuring functions. The specific use of these controls is described in the calibration instructions.

DIGITAL READOUT

The instrument is normally supplied with six readout tubes: polarity display; overrange display; and four 0 thru 9 digital and decimal displays (left to right respectively).

A function tube (displaying MV, DC, AC or KΩ) is offered as an optional accessory and when utilized is located on the extreme right of the readout. The polarity display (S/N's X-2.307 and subsequent) also indicates an overload condition, i.e., when the input exceeds the limits of a particular manually selected range, the left-most readout tube will display Ω_L. With the range switch in the AUTO position, the overload display will only illuminate when the extreme limits of the instrument have been reached. Refer to specifications for limits of each measurement function.

CHAPTER III

CALIBRATION

In the calibration instructions provided in this chapter, it is assumed, that the instrument is in good working order and only requires calibration. If any components are defective, it may be difficult, if not impossible, to calibrate the instrument.

SCOPE

The basic DC calibration procedure is divided into six distinct areas: reference adjustment; zero offset adjustment; 10-volt range calibration for a positive input; 10-volt range calibration for a negative input; 100-volt range calibration; and 1000-volt range calibration.

Since the Series X-2 instruments are capable of millivolts, AC and ohms measurements, calibration procedures for these functions are also included.

DC VOLTAGE CALIBRATION

EQUIPMENT REQUIRED

1. A voltmeter capable of measuring -20 VDC (±1 MVDC).
2. An extension board, NLS No. 1009-41.
3. A voltage standard between 9.000 volts and 11.998 volts.
4. A voltage standard between 90.00 volts and 119.98 volts.
5. A voltage standard between 900.0 volts and 1000.0 volts.

NOTE

It should be noted that the error in making a measurement with the Series X-2 DVM can be as much as the stated accuracy of the instrument plus the accuracy of the voltage standards used in its calibration.

INITIAL PREPARATION

1. Remove the cover of the instrument by removing the four screws (two on each side) attaching the cover to the chassis (Figure 3-1).
2. Plug the power cord into a 115 VAC, 50-60 Hz, single phase power source.
3. Place the power switch in the STBY. position and allow 30 minutes for instrument warm-up.

PROCEDURE

Reference Adjustment

1. Remove the reference assembly, P/N 37-36, from instrument (Figure 3-2).
2. Insert extension board into J12 main board assembly.
3. Mount reference assembly on top of extension board by inserting reference board pins into extension board. Use care to ensure proper pin alignment.
4. Connect a voltmeter capable of measuring -20 VDC (±1 MVDC) between ground and -20V output, pin 33 and pin 39 (Figure 3-3).
5. Adjust R1 (Figure 3-3) on reference assembly until test meter reads -20V (±1 MVDC).

Remove reference assembly from extension board and remove extension board from instrument.

7. Insert reference assembly into J12.

Zero Offset Adjustment.

1. Place function switch in the DC position.
2. Place power switch in the ON position.
3. Place range switch in the 10 position.
4. Connect the red and black clips of the DVM input cable together.
5. Rotate the DVM OFFSET potentiometer R1, located on the rear of the instrument, to a position which causes the readout to display ±0.000DC.

10-Volt Range Calibration for a Positive Input Voltage

1. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 3 under Equipment Required. Connect the read lead to the positive terminal.
2. Apply approximately 9.5 volts.
3. The numerical value displayed in the readout should be equal to the voltage of the voltage standard. If it is not, adjust potentiometer R30 (Figure 3-2) of the Attenuator Assembly, P/N 37-39, until the readout displays the correct value. Note that input impedance of DVM is 10 Megohms.

NOTE

Potentiometers R31 and R38 (Figure 3-2) have been adjusted and sealed at the factory and must not be adjusted in the field. They are temperature coefficient compensators for the ± prime calibration.

Figure 3-1. Cover Removal

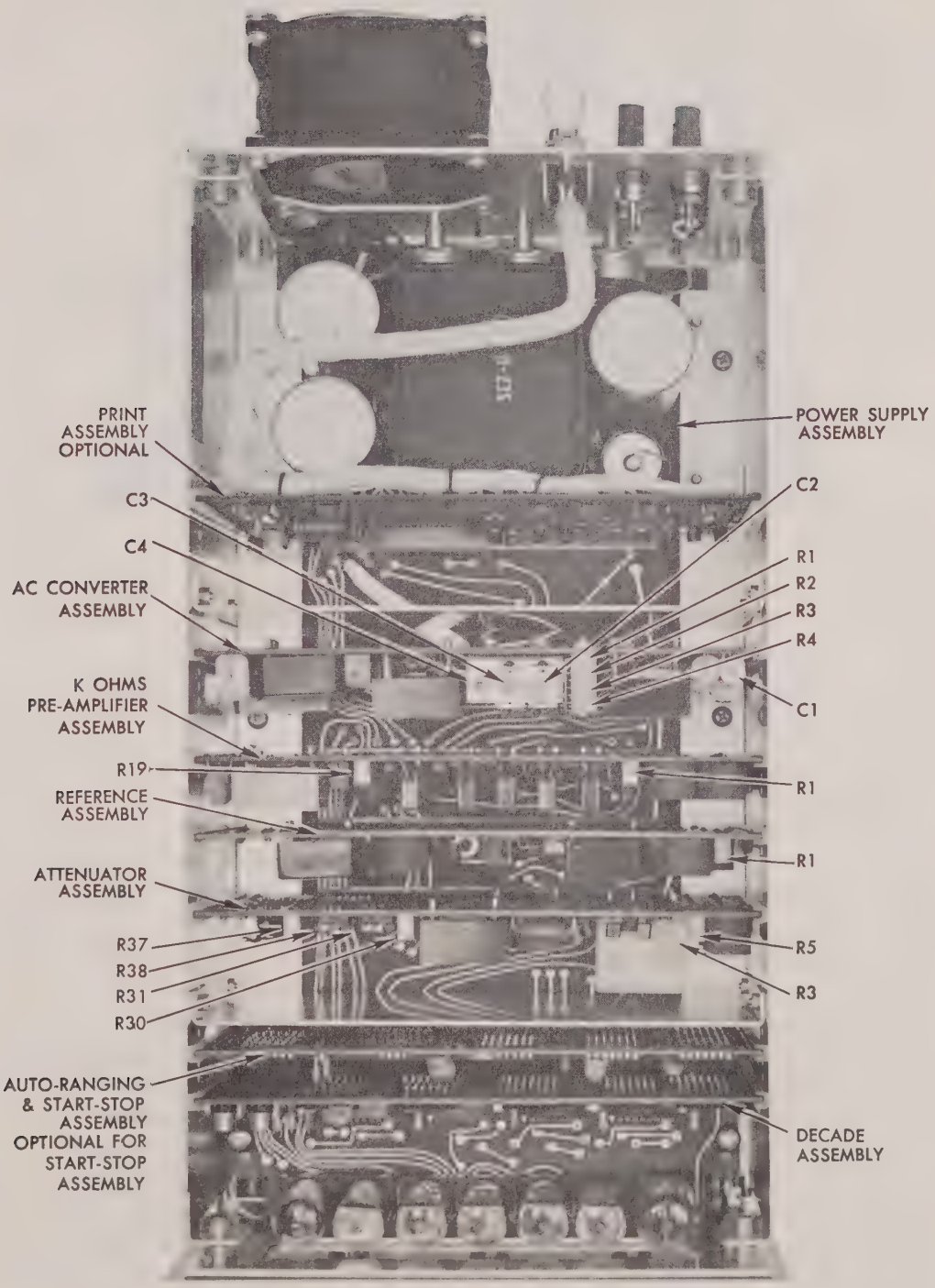


Figure 3-2. Location of Major Subassemblies and Adjustment Points

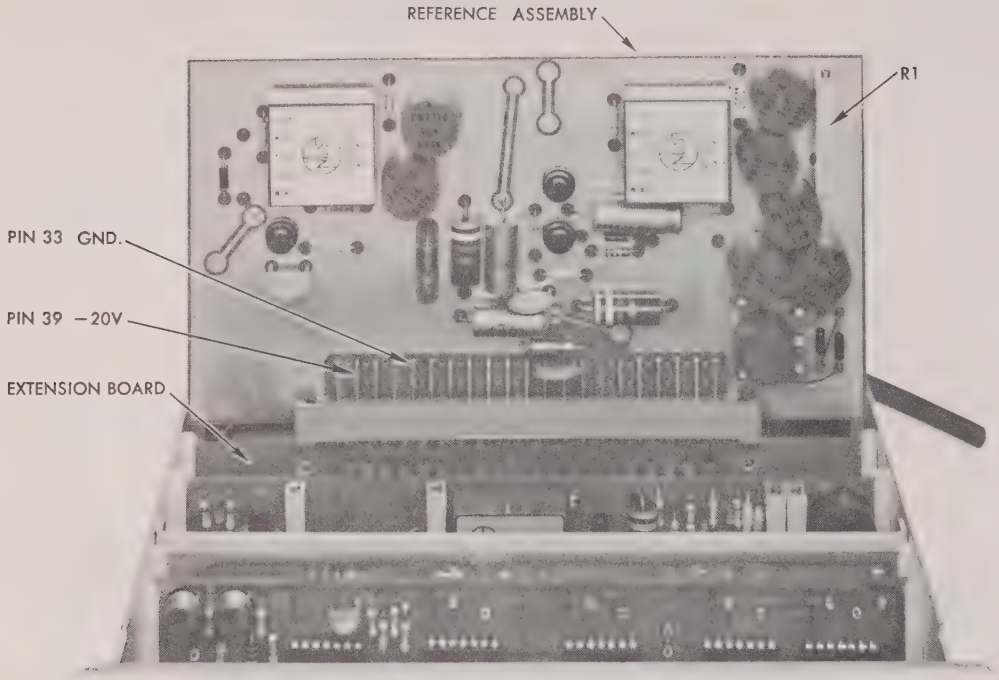


Figure 3-3. Reference Adjustment

10-Volt Range Calibration for a Negative Input Voltage

1. Reverse the connections to the voltage standard.

2. Apply approximately 9.5 volts.

3. The numerical value displayed in the readout should be equal to the voltage of the voltage standard. If it is not, adjust potentiometer R37 (Figure 3-2) of the Attenuator Assembly until the readout displays the correct value.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

100-Volt Range Calibration

1. Place the range switch in 100 position.

2. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 4 under Equipment Required. Connect the red lead to the positive terminal.

3. Apply approximately 95 volts.

4. The numerical value displayed in the readout should be equal to the voltage of the voltage standard. If it is not, adjust potentiometer R5 (Figure 3-2) of the Attenuator Assembly until the readout displays the correct value.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

1000-Volt Range Calibration

1. Place the range switch in the 1000 position.
2. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 5 under Equipment Required. Connect the red lead to the positive terminal.
3. Apply approximately 950 volts.
4. The numerical value displayed in the readout should be equal to the voltage standard. If it is not, adjust potentiometer R3 (Figure 3-2) of the Attenuator Assembly until the readout displays the correct value.

AC CONVERTER CALIBRATION

ADDITIONAL EQUIPMENT REQUIRED

1. An Audio Voltage Standard between 1 volt, 200 Hz - 10K Hz and 500 volts, 200 Hz - 10K Hz.

INITIAL PREPARATION

1. Ensure that the instrument is properly calibrated in the DC voltage measurement function and ensure a 30-minute warm-up period.

PROCEDURE

1. Place the function switch in the AC position.
2. Place the range switch in the 1000 position.
3. Place the power switch in the ON position.
4. Connect the red and black clips of the DVM input cable together.
5. Rotate the AC OFFSET potentiometer, R2, located on the rear of the instrument, to a position which causes the readout to display 0.000 AC.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

CAUTION

Do not apply more than 500 VAC or damage to the AC Converter Assembly may result.

6. Connect the red lead of the DVM input cable to the AC HI terminal and the black lead to the AC LO terminal of the Audio Voltage Standard
7. Apply approximately 450.00 volts, 200 Hz and adjust R1 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.
8. Apply approximately 450.00 volts, 10K Hz and adjust C1 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

WARNING

Use extreme caution in performing the following steps as dangerously high voltage will be employed.

9. Place the range switch in the 100 position. Apply approximately 90.00 volts, 200 Hz and adjust R2 (Figure 3-2) of the AC Converter Assembly until the

numerical value displayed in the readout is equal to the voltage applied.

10. Apply approximately 90.00 volts 10 K Hz and adjust C2 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

11. Place the range switch in the 10 position. Apply approximately 9.000 volts, 200 Hz and adjust R3 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

12. Apply approximately 9.000 volts, 10K Hz and adjust C3 of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

13. Apply approximately 0.9000 volts, 200 Hz and adjust R4 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

14. Apply approximately 0.9000 volts, 10K Hz and adjust C4 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

OHMS CONVERTER AND PRE-AMPLIFIER CALIBRATION

ADDITIONAL EQUIPMENT REQUIRED

1. An ohms standard accurate to 0.01%.

2. A voltage standard between 90.00 millivolts and 1199.98 millivolts.

INITIAL PREPARATION

1. Ensure that the instrument is properly calibrated in the DC voltage measurement function and ensure a 30-minute warm-up period.

PROCEDURE

1. Place the power switch in the ON position.

2. Place the range switch in the 100 position.

3. Place the function switch in the MV position.

4. Connect the red and black clips of the DVM input cable together.

5. Rotate the KΩ/MV OFFSET R3 potentiometer, located at the rear of the instrument, to a position which causes the readout to display 00.00 MV.

6. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 2 under Additional Equipment Required. Connect the red lead to the positive terminal.

7. Apply approximately 95.00 millivolts and adjust R19 of the Ohms Converter/Pre-Amplifier Assembly (Figure 3-2) until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

8. Place the range switch in the 1000 position. (S/N's X-2.189 & subsequent).

9. Apply approximately 950.00 millivolts and adjust R37 (located to the left of R19) of the ohms converter/pre-amplifier assembly until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

10. Place the range switch in the 10000 position.

11. Place the function switch in the KΩ position.

12. Connect the red and black clips of the DVM input cable together.

13. Rotate the KΩ/MV OFFSET R3 potentiometer, located on the rear of the instrument, to a position which causes the readout to display 0000 KΩ.

14. Connect the two leads of the DVM input cable to the output terminals of the ohms standard.

15. Apply approximately 9000 KΩ and adjust R1 (Figure 3-2) of the ohms converter and pre-amplifier assembly until the numerical value displayed in the readout is equal to the ohmic value applied.

PRECISION PRE-AMPLIFIER CALIBRATION

INITIAL PREPARATION

1. Ensure that the instrument is properly calibrated in the DC voltage measurement function and ensure a 30-minute warm-up period.

PROCEDURE

1. Place the power switch in the ON position.

2. Place the range switch in the 100 position.

3. Place the function switch in the MV position.

4. Connect the red and black clips of the DVM input cable together.

5. Rotate the KΩ/MV OFFSET R3 potentiometer, located on the rear of the instrument, to a position which causes the readout to display 00.00 MV.

6. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 2 under Additional Equipment Required. Connect the red lead to the positive terminal.

7. Apply approximately 95.00 millivolts and adjust R1 of the Ohms Converter/Pre-amplifier assembly (Figure 3-4) until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

8. Place the range switch in the 1000 position.

9. Apply approximately 950.00 millivolts and adjust R2 of the preamplifier assembly until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

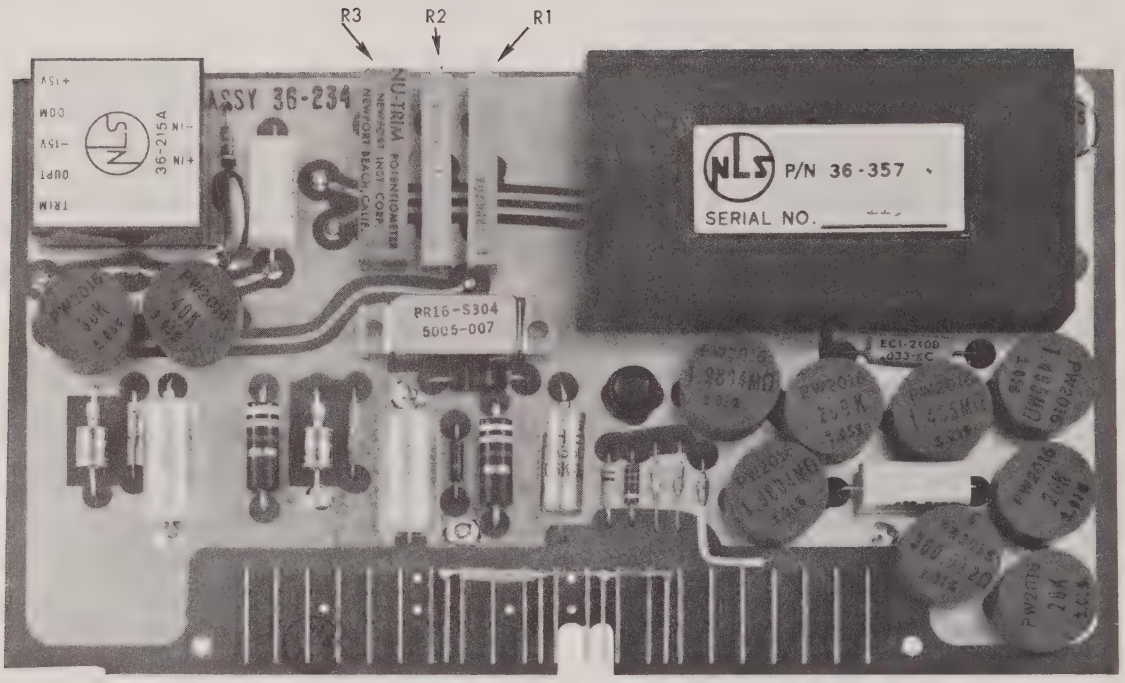


Figure 3-4. Precision Pre-amplifier Assembly Adjustment Points

CHAPTER IV

MAINTENANCE

In the Series X-2 Digital Voltmeter, virtually all circuit components are assembled on plug-in modules. Thus maintenance problems are simplified to the point where the instrument can be kept operating without the need for highly trained maintenance personnel. Because of this plug-in design, downtime is held to a minimum; the unit can be kept operating in locations from which it would be impractical or inconvenient to send the instrument to a repair facility or to the manufacturer. Only a very few minutes are needed to replace all the plug-in boards. By using trial-and-error techniques the instrument can be rapidly returned to service, and the defective module repaired at a later date.

For a general understanding of the principles of operation of the Series X-2 DVM, refer to Figures 4-1 through 4-15. For a more detailed analysis, refer to the schematic and wiring diagrams at the end of this manual.

In order to pursue the plug-in philosophy to the fullest, spare modules as listed in Section V, Recommended Spare Parts List, should be kept in stock.

If it is desired to measure voltages and check waveforms on a particular plug-in module, a 41-pin extension board will be required to raise the board so that pin contacts become accessible. These boards, NLS part number 1009-41, may be ordered from any NLS representative or from the NLS Main Office in Del Mar, California.

TROUBLESHOOTING

For troubleshooting information, refer to Table 4-1.

DIGITAL READOUT REPLACEMENT

The readout tubes providing the digital, polarity and function displays have exceedingly long-life expectancy and rarely require replacement. However, to replace a readout tube in the event of failure, perform the following steps:

1. Remove the cover from the instrument by removing the four screws (two on each side) attaching the cover to the chassis.

2. Remove the decade assembly (front board) from the instrument.

3. Firmly grasp the decade assembly with one hand and the malfunctioning tube with the other.

4. With a rocking motion, carefully pull the tube from its socket.

5. Install new tube, using care to properly align pins into tube socket, and replace decade board and cover in reverse order of removal.

FAN LUBRICATION

Under normal operating conditions, the ventilating fan (S/N's X-2.157 thru X-2.462 and those earlier S/N's so modified) should be lubricated every two or three months.

To lubricate the fan, remove the blue slotted plug from rear of fan assembly and apply two or three drops of Rotron M-21 lubricant.

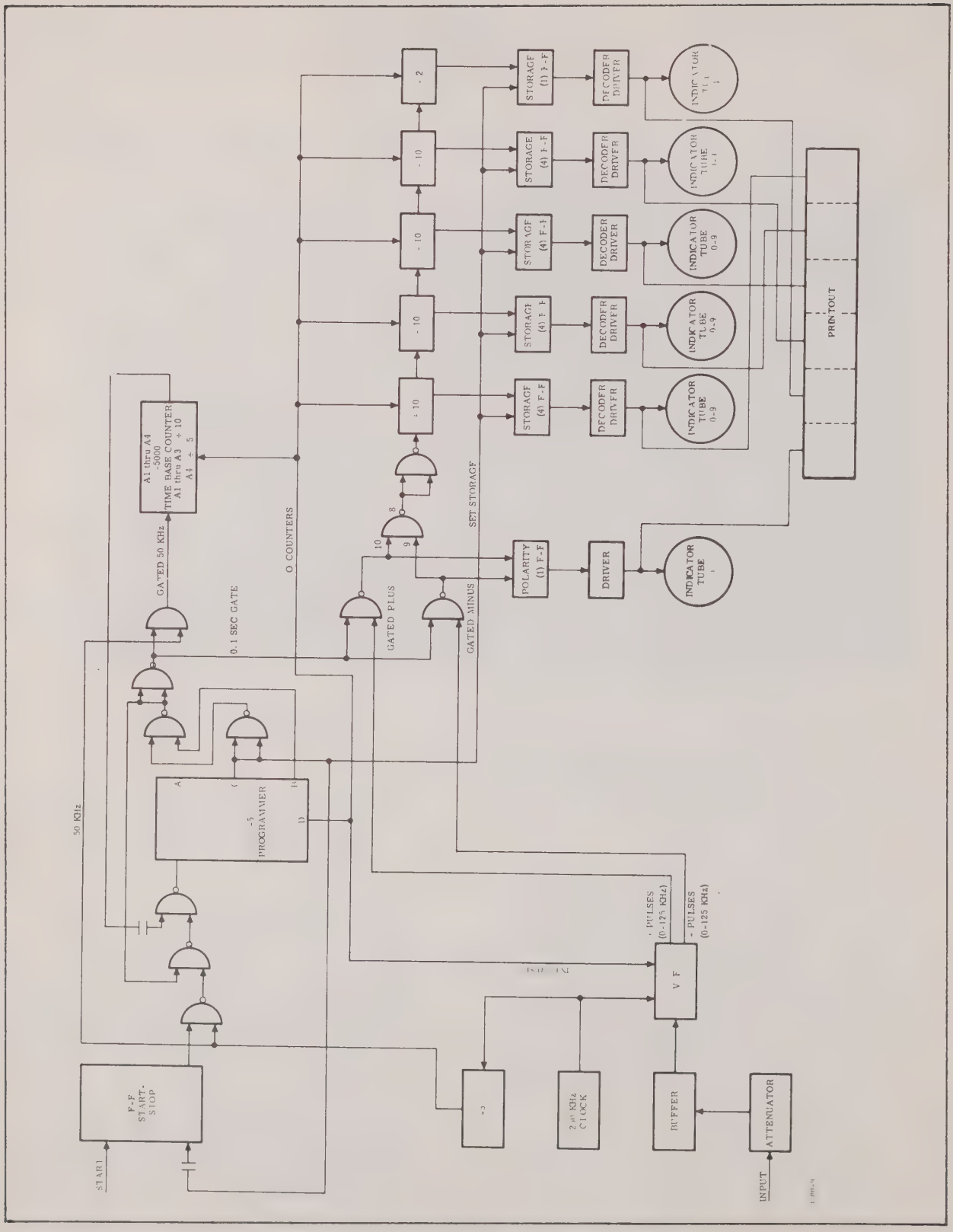


Figure 4-1. Block Diagram Series X-2 DVM

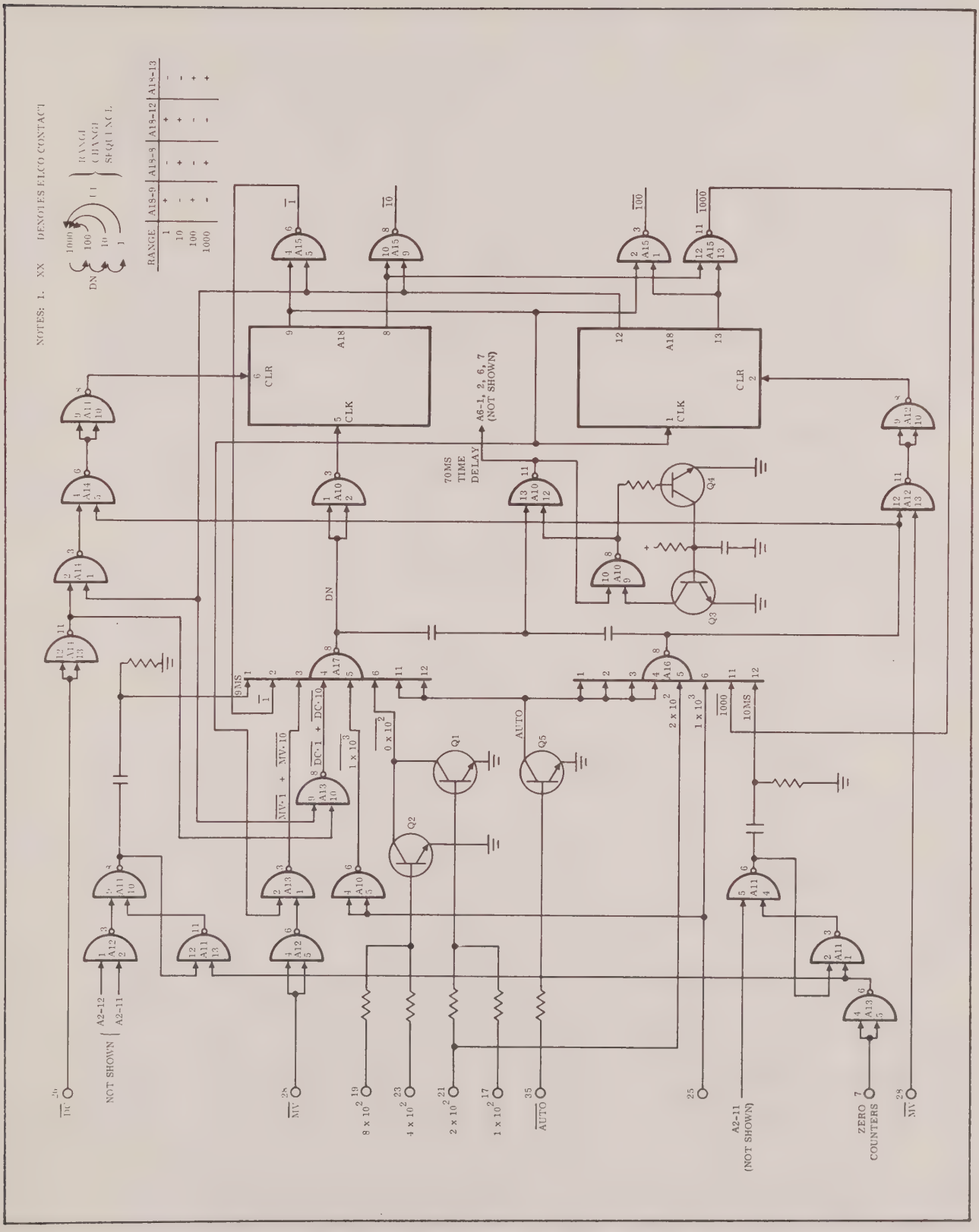


Figure 4-2. Simplified Diagram, Auto-ranging

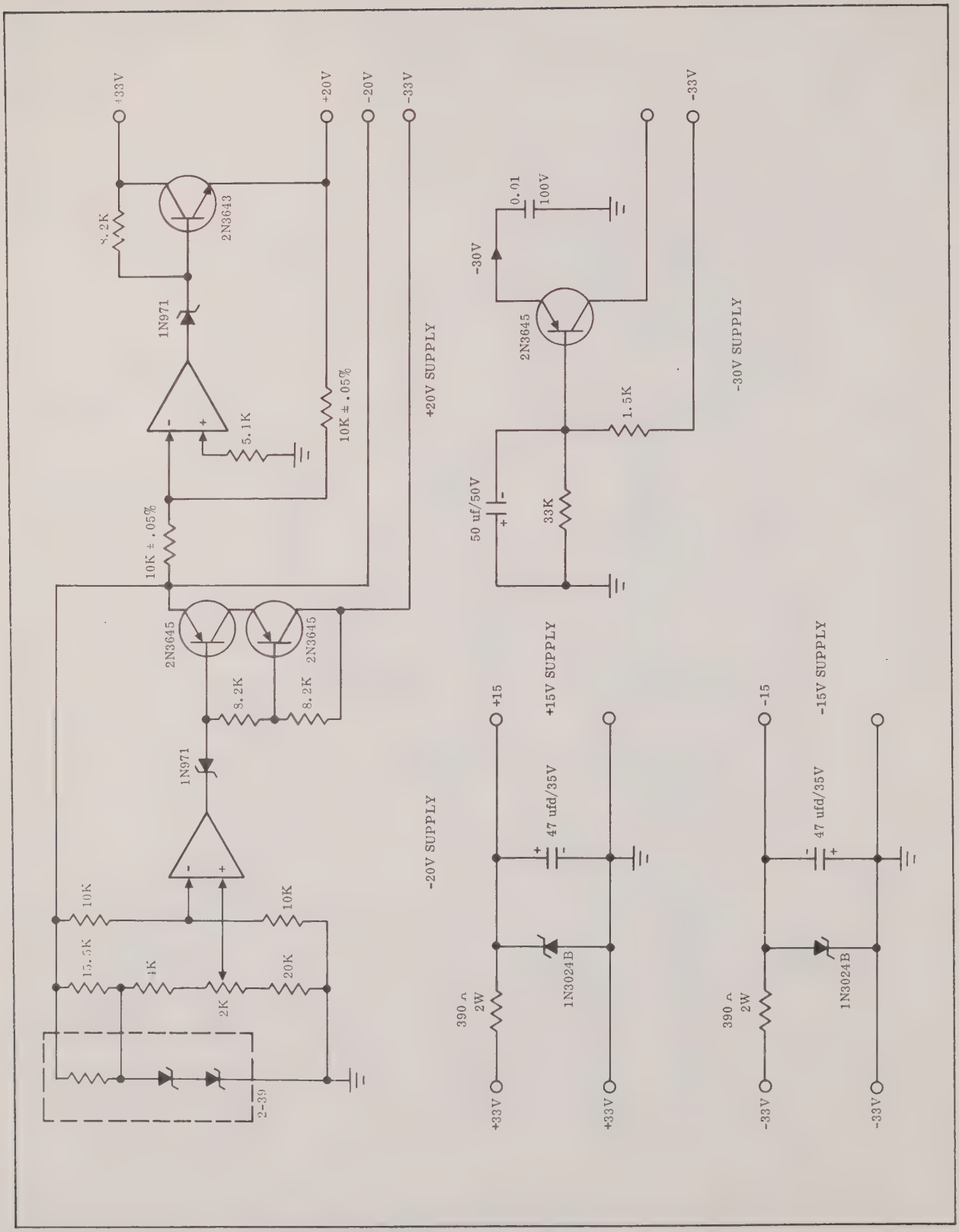


Figure 4-3. Simplified Diagram, Reference Supply

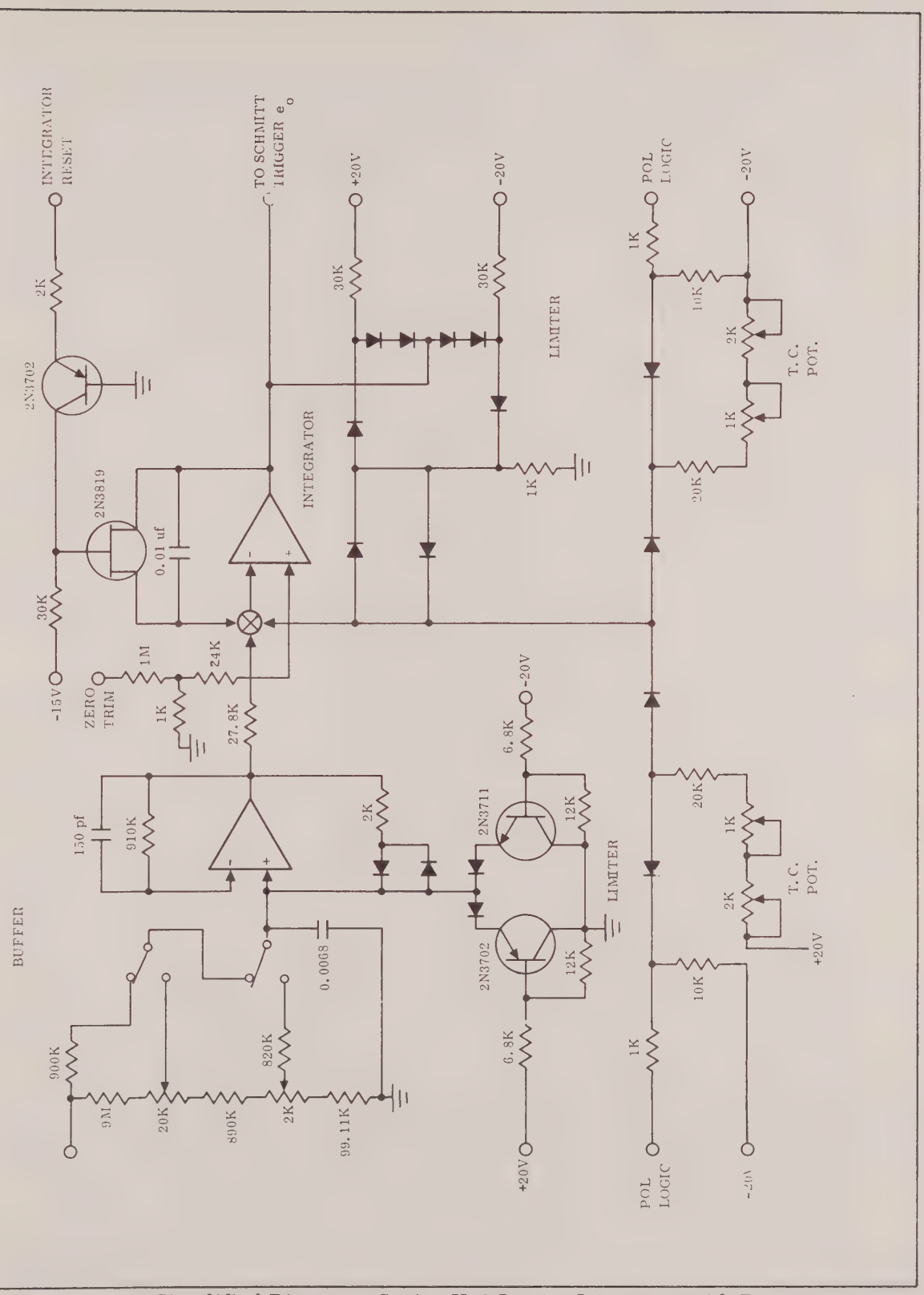
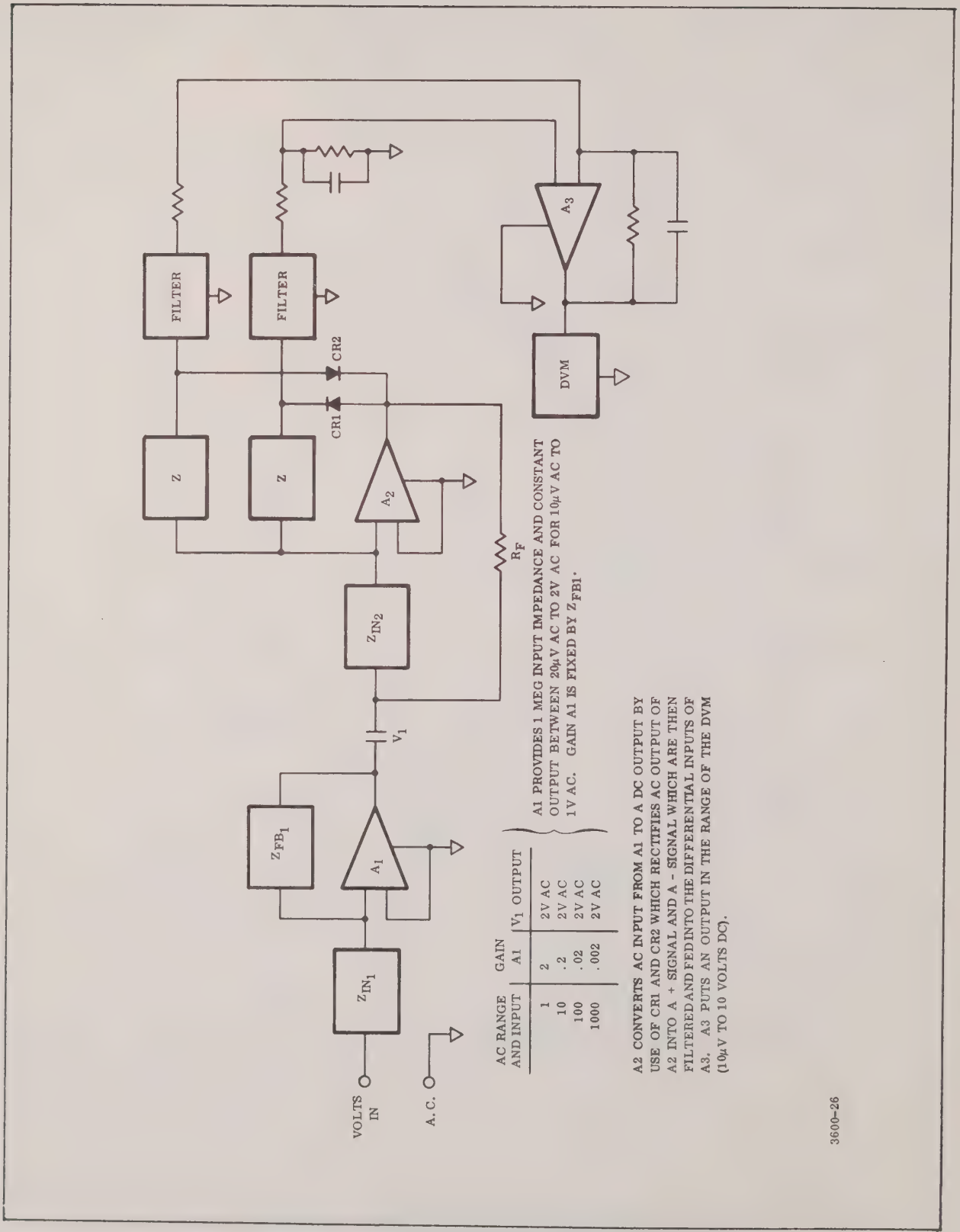


Figure 4-4. Simplified Diagram, Series X-2 Input - Integrator with Resetter Circuitry and Temperature Compensation Potentiometers


FILTER
FILTER
CR2
CR1
Z
Z
A2
A3
DVM
RF
ZIN2
V1
ZFB1
A1
ZIN1
VOLTS IN
A.C.
A1 PROVIDES 1 MEG INPUT IMPEDANCE AND CONSTANT OUTPUT BETWEEN 20μV AC TO 2V AC FOR 10μV AC TO 1V AC. GAIN A1 IS FIXED BY ZFB1.
A2 CONVERTS AC INPUT FROM A1 TO A DC OUTPUT BY USE OF CR1 AND CR2 WHICH RECTIFIES AC OUTPUT OF A2 INTO A + SIGNAL AND A - SIGNAL WHICH ARE THEN FILTERED AND FED INTO THE DIFFERENTIAL INPUTS OF A3. A3 PUTS AN OUTPUT IN THE RANGE OF THE DVM (10μV TO 10 VOLTS DC).
3600-26

AC RANGE AND INPUT	GAIN A1	V1 OUTPUT
1	2	2V AC
10	.2	2V AC
100	.02	2V AC
1000	.002	2V AC

Figure 4-5. Simplified Diagram AC Converter

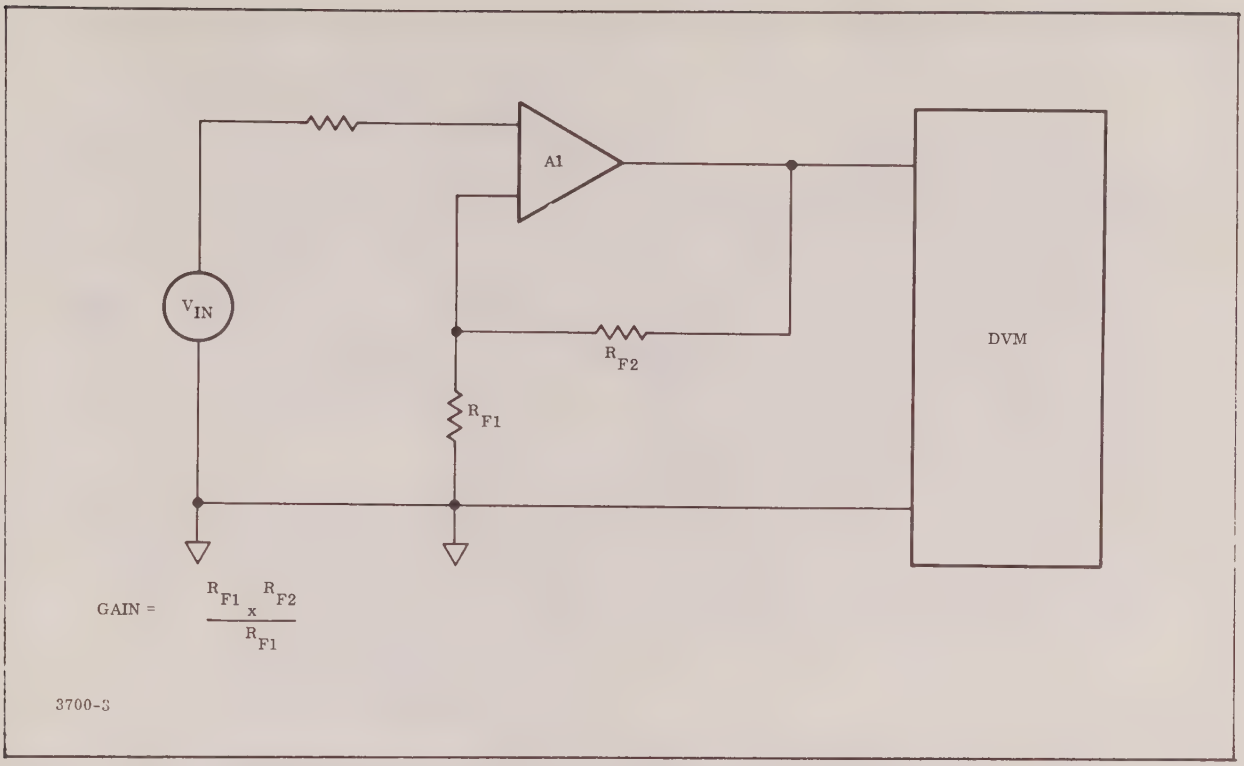
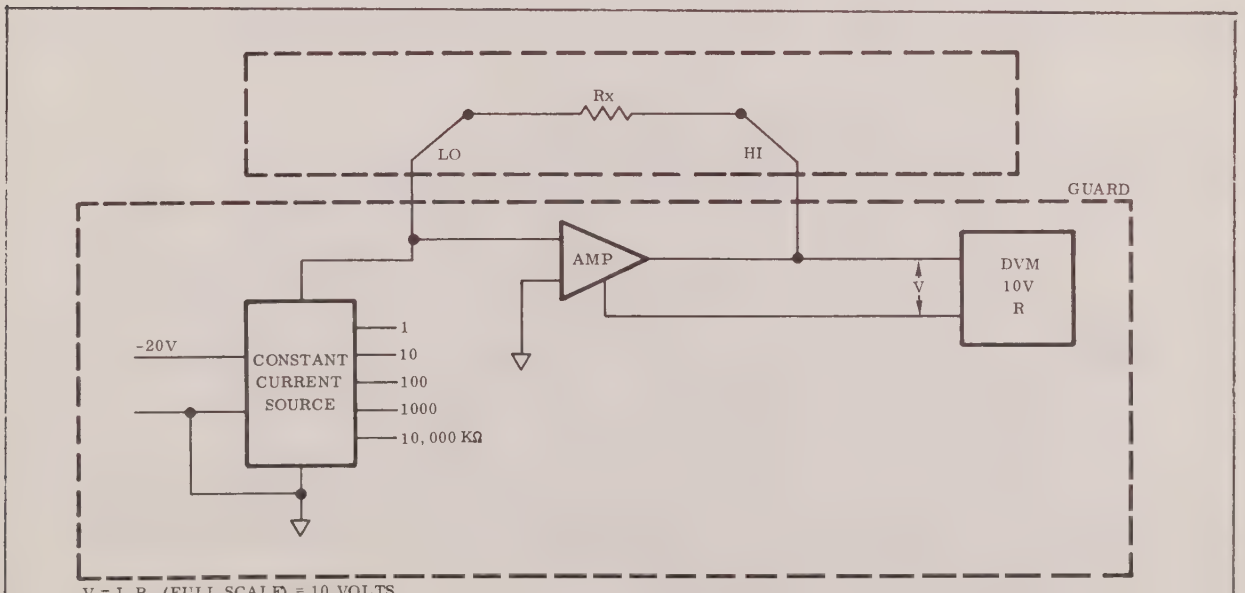


Figure 4-6. Simplified Diagram Pre-amplifier



R_X	I
1K	10MA
10K	1MA
100K	100μA
1000K	10μA
10,000K	1μA

Figure 4-7. Simplified Diagram Ohms Converter

TRUTH TABLES

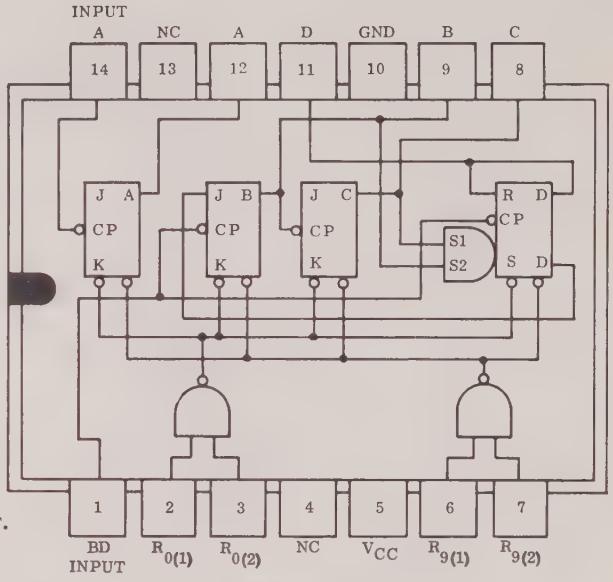
BCD COUNT SEQUENCE
(SEE NOTE 1)

COUNT	OUTPUT			
	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

RESET/COUNT (SEE NOTE 2)

RESET INPUTS				OUTPUT
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	D C B A
1	1	0	X	0000
1	1	X	0	0000
X	0	1	1	1001
0	X	1	1	1001
1	1	1	1	1001
X	0	X	0	COUNT
0	X	0	X	COUNT
0	X	X	0	COUNT
X	0	0	X	COUNT

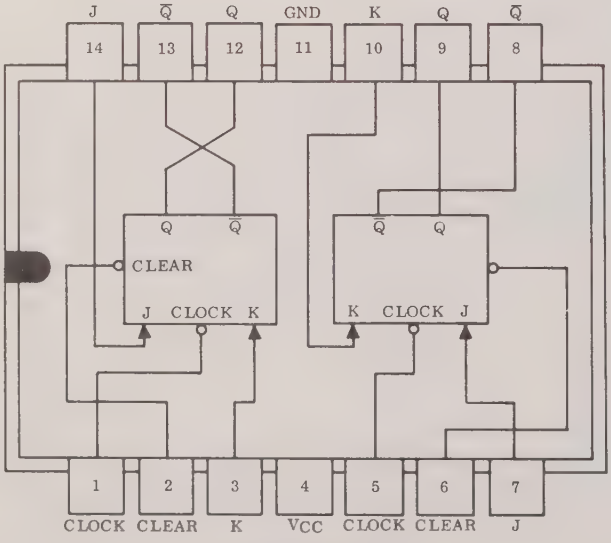
NOTES:
1. OUTPUT A CONNECTED TO INPUT BD FOR BCD COUNT.
2. X INDICATES THAT EITHER A LOGICAL 1 OR A LOGICAL 0 MAY BE PRESENT.



POSITIVE LOGIC
SEE TRUTH TABLES
NC–NO INTERNAL CONNECTION

3700-10

Figure 4-8. Type SN7490N Decade Counter



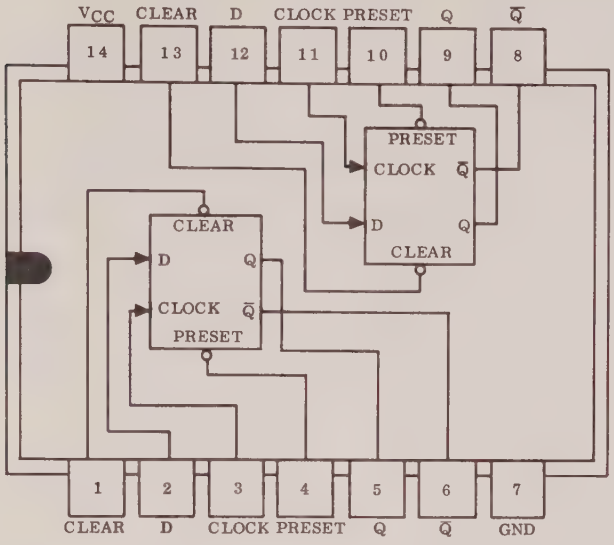
POSITIVE LOGIC
LOW INPUT TO CLEAR SETS Q TO LOGICAL 0
REGARDLESS OF CLOCK STATE.

3700-11

TRUTH TABLE (EACH FLIP-FLOP)		
t_n		$t_n + 1$
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

NOTES:
1. t_n = BIT TIME BEFORE CLOCK PULSE.
2. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE.

Figure 4-9. Type SN7473N Dual J-K Master-Slave Flip-Flop



POSITIVE LOGIC

a. LOW INPUT TO CLEAR SETS Q TO LOGICAL 0.
b. LOW INPUT TO PRESET SETS Q TO LOGICAL 1.
c. CLEAR OR PRESET INPUTS DOMINATE REGARDLESS OF CLOCK AND D INPUTS.

3700-12

TRUTH TABLE (EACH FLIP-FLOP)

t_n	$t_n + 1$	
INPUT D	OUTPUT Q	OUTPUT $\overline{Q}$
0	0	1
1	1	0

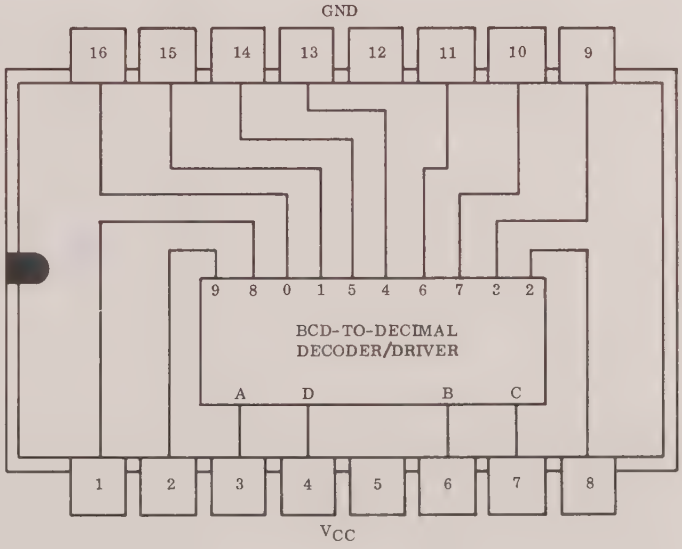
NOTES:
1. t_n = BIT TIME BEFORE CLOCK PULSE.
2. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE.

Figure 4-10. Type SN7474N Dual D-Type Edge-Triggered Flip-Flop

TRUTH TABLE

INPUT				OUTPUT
D	C	B	A	ON ‡
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

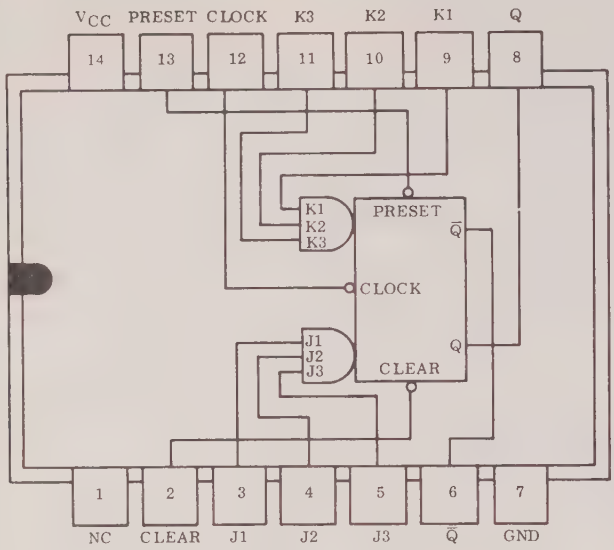
‡ ALL OTHER OUTPUTS ARE OFF.



3700-13

POSITIVE LOGIC
SEE TRUTH TABLE

Figure 4-11. Type SNX7441N BCD-to-Decimal Decoder/Driver



TRUTH TABLE		
t_n		$t_n + 1$
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

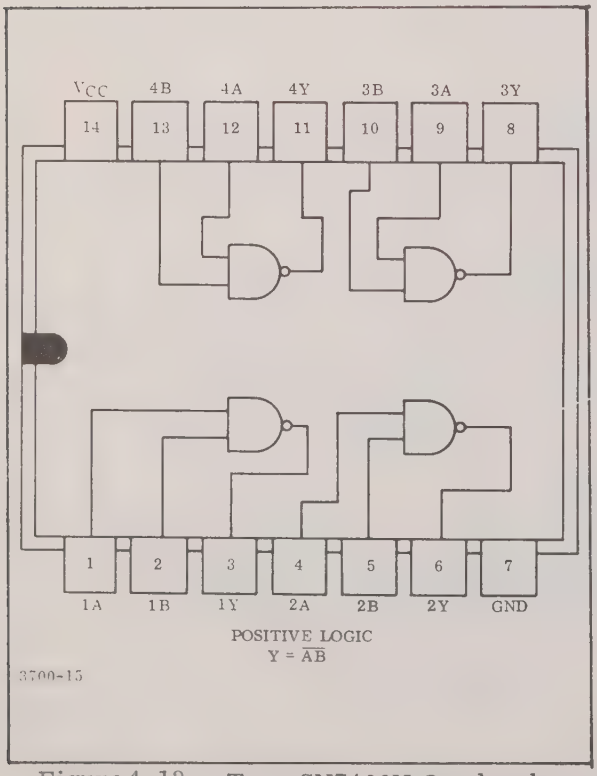
NOTES: 1. J = J1·J2·J3
2. K = K1·K2·K3
3. t_n = BIT TIME BEFORE CLOCK PULSE.
4. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE.

POSITIVE LOGIC
LOW INPUT TO PRESET SETS Q TO LOGICAL 1
LOW INPUT TO CLEAR SETS Q TO LOGICAL 0

NC–NO INTERNAL CONNECTION.

3700-14

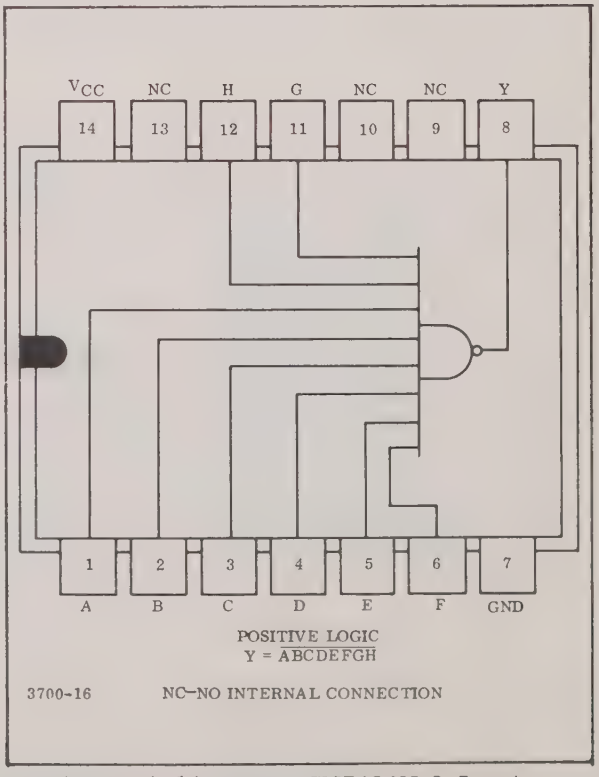
Figure 4-12. Type SN 7472NJK Master-Slave Flip-Flop



POSITIVE LOGIC
$Y = \overline{AB}$

3700-15

Figure 4-13. Type SN7400N Quadruple 2-Input Positive Nand Gate



POSITIVE LOGIC
$Y = \overline{ABCDEFGH}$

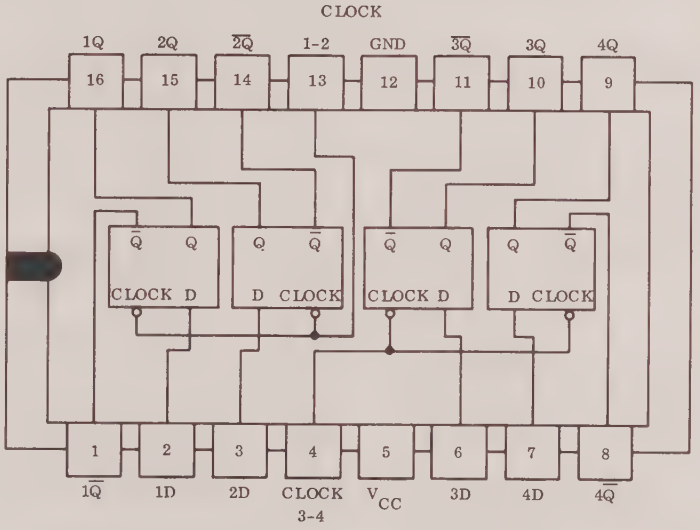
3700-16 NC–NO INTERNAL CONNECTION

Figure 4-14. Type SN7430N 8-Input Positive Nand Gate

TRUTH TABLE (EACH LATCH)		
t_n	$t_n + 1$	
D	Q	$\overline{Q}$
1	1	0
0	0	1

NOTES: 1. t_n = BIT TIME BEFORE CLOCK PULSE.

2. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE



3700-17

Figure 4-15. Type SN7475N Quadruple Bistable Latch

TABLE II. Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTION
No readout when the POWER switch is positioned to ON	No line-voltage	Check line-voltage
		Check power cable
	230-volt instrument plugged into 115-volt power outlet	Plug into 230-volt power outlet
	Open fuse F1 in power supply	Replace fuse
	200V power supply defective	Repair 200V power supply C4, R4, R5, R15, CR9, CR12, and Q6
No response to input in KΩ function	Open fuse F1 in Kμ/MV Converter Assembly	Replace fuse
Blank indicator in readout	Defective indicator tube	Replace indicator tube
	Defective indicator tube driver	Replace A11, A12, A13, or A14
Samples and measures when POWER switch is in REMOTE position	POWER switch defective	Replace switch S1
Does not sample continuously when POWER switch is in ON position	POWER switch defective	Replace switch S1
	Defective Attenuator Assembly	Repair or replace
	Defective Reference Assembly	Repair or replace
	Defective Start/Stop and Auto-Range Assembly	Repair or replace
Errors in one polarity but not in other	10V range not properly calibrated	Check calibration and adjust as necessary
Samples but does not change readout	Defective Decade Assembly	Repair or replace
Function does not control the instrument properly	Function switch defective	Replace switch S3
Range switch does not control instrument properly, or incorrect decimal point positioning	Defective range switch	Replace switch S2
	Defective Start/Stop and Auto-Range Assembly	Repair or replace
All indicators on simultaneously (blur)	+5V power supply defective	Repair +5V power supply
Unit does not function in AC mode.	Defective function switch	Replace switch S3
	Defective AC/DC Converter Assembly	Repair or replace

TABLE II. Troubleshooting (Con't)

SYMPTOM	PROBABLE CAUSE	CORRECTION
Readings erratic	Defective input cable	Replace input cable
	Defective Reference Assembly	Repair or replace
	Defective Attenuator Assembly	Repair or replace
Some or all decades go to nines	Defective Decade Assembly	Repair or replace
Improper polarity	Defective Decade Assembly	Repair or replace
	Defective Start/Stop and Auto-Range Assembly	Repair or replace
Improper range changing	Defective Start/Stop and Auto-Range Assembly	Replace
+ or - offset in DC	Zero not properly adjusted	Adjust zero
	10V range not properly calibrated	Check calibration and adjust as necessary
Errors in one range but not in others	Range in question not properly calibrated	Check calibration and adjust as necessary
	Defective range resistor on Attenuator Assembly	Replace range resistor
	Defective range relay on Attenuator Assembly	Replace range relay
Offset in low range but not in others	Group loop on input	Check input hookup and eliminate ground loop
Drift	Defective Reference Assembly	Repair or replace
	Defective Attenuator Assembly	Repair or replace
	Defective Start/Stop and Auto-Range Assembly	Repair or replace

CHAPTER V

RECOMMENDED SPARE PARTS LIST

Part No.	Description	Qty.
37-30	Decade Assembly (S/N's X-2 . 1 thru X-2. 301	1
37-36	Reference Assembly (S/N's X-2 . 1 thru X-2. 462)	1
37-39	Attenuator Assembly (S/N's X-2 . 1 thru X-2, 462)	1
37-69	Start-Stop Assembly	1
37-160	Decade Assembly (S/N's X-2. 302 & Subsequent)	1
37-272	Reference Assembly (S/N's X-2. 463 & Subsequent)	1
37-275	Attenuator Assembly (S/N's X-2. 463 & Subsequent)	1
37-360	Decade Assembly (Replaces 37-160)	1
SP2A2	Fan Assembly (S/N's X-2. 157 thru X-2. 462 & others so modified)	1
1009-41	Extension Board (Test Equipment)	1
31300. 5	Fuse, 3AGO. 5A Slo-Blo	6
B5440	Readout Indicator Tube (0 thru 9)	1
B5441	Readout Indicator Tube (0 thru 9 & Decimal)	1
B5448	Readout Indicator Tube (Polarity)	1
2BC-AL-36	Cable Assembly	1
	ACCESSORIES	
54361	Readout Indicator Tube (Function)	1
37-33	Start-Stop & Auto Range Assembly	1
37-42	Ohms Converter & Pre-Amp Assembly (S/N's X-2. 1 thru X-2. 462)	1
37-45	AC Converter Assembly, 10K Hz (S/N's X-2. 1 thru X-2. 462)	1
37-77	AC Converter Assembly, 100 KHz (S/N's X-2. 1 thru X-2. 462)	1
37-89	Print Board Assembly (S/N's X-2. 1 thru X-2. 462)	1
37-278	Ohms Converter & Pre-Amp Assembly (S/N's X-2. 463 & Subsequent)	1
37-281	AC Converter Assembly 10K Hz (S/N's X-2. 463 & Subsequent)	1
37-315	AC Converter Assembly 100K Hz (S/N's X-2. 463 & Subsequent)	1
37-316	Print Board Assembly (S/N's X-2. 463 & Subsequent)	1

APPENDIX

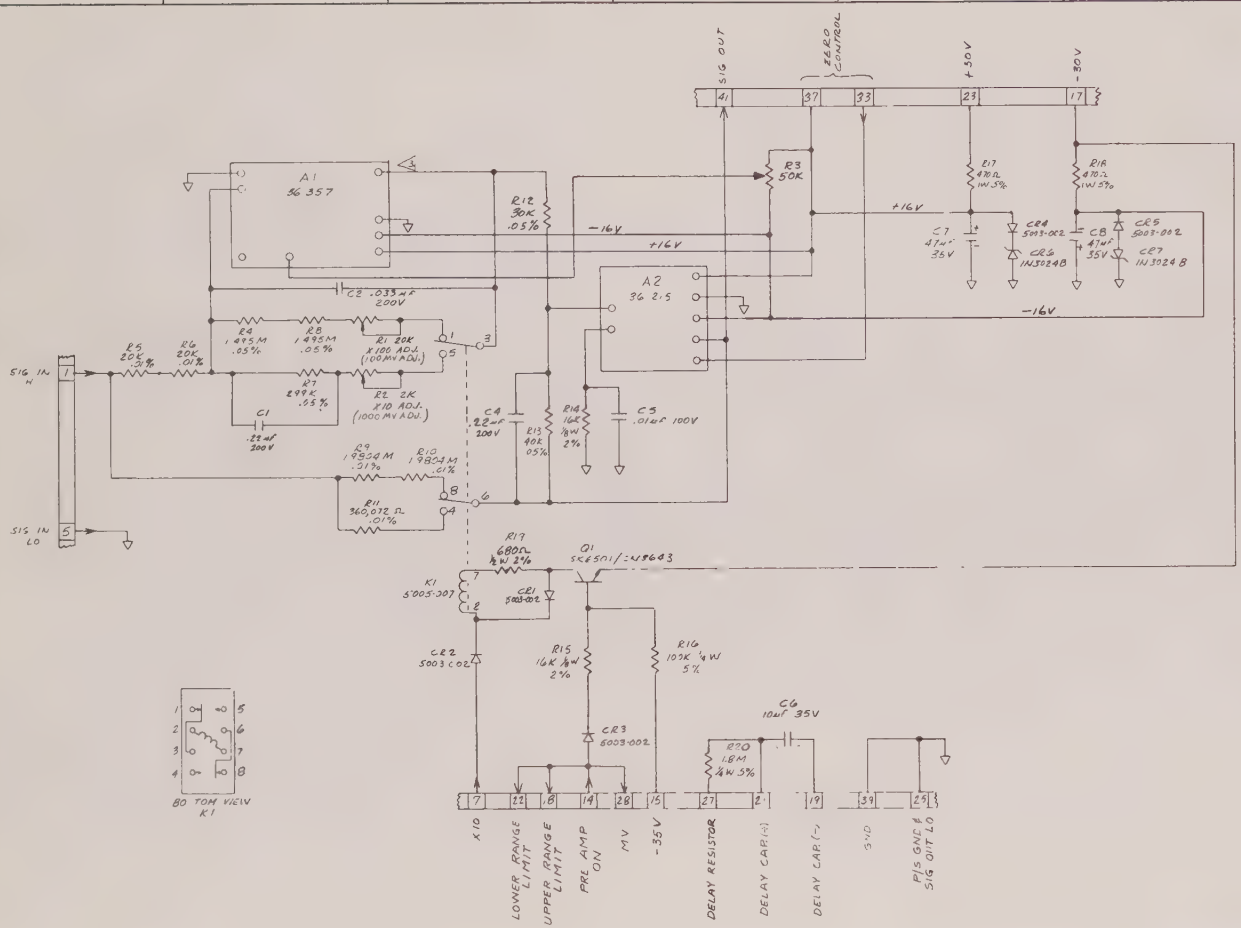
SHIPPING INSTRUCTIONS

Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvers. If the original shipping container is in good condition, it may be used.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.



WITH INPUT LEADS SHORTED TOGETHER ADJUST R3 UNTIL THIS POINT MEASURES 0 VDC ± 500uV ON BOTH RANGES. ALLOW 15 MIN. WARM UP TIME.

1. R4 THRU R13 ARE NLS W.W.P. PW2016 RESISTORS.

NOTES

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

CONTR. NO.
DRAWN Rinaldi 4-26-67
CHECK SOULÉ 5-2-67
APPR Hoffman 5-3-67
RELEASE DATE 5-5-67

MATERIAL
SEE SH-1

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

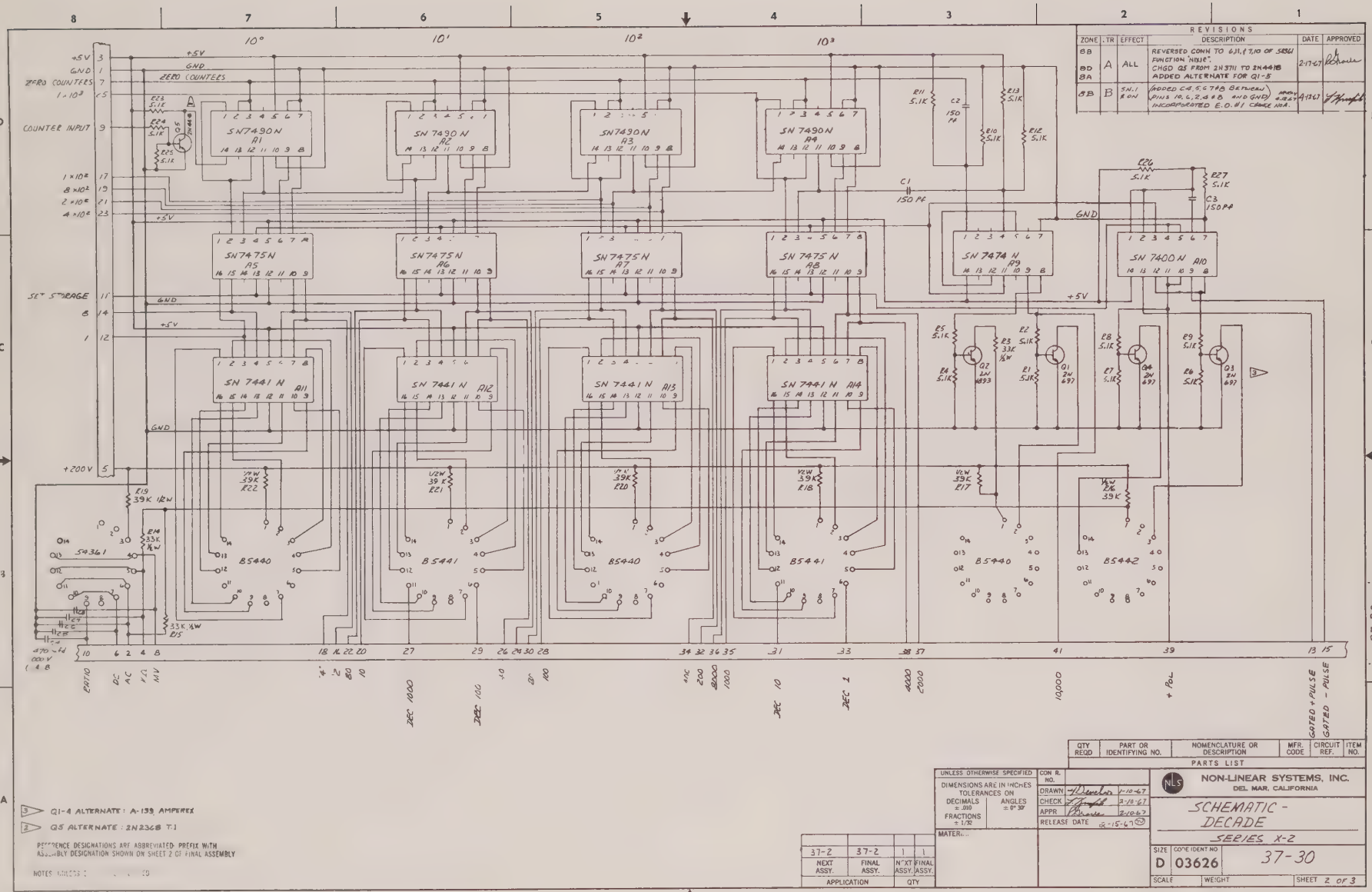
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC - MV CONVERTER ASSY
SERIES XI

SIZE	CODE IDENT NO.	
D	03626	36-658

SCALE | WEIGHT | SHEET 2

36-658 SH 2



REVISIONS					
ZONE	LTR	EFFECT	DESCRIPTION	DATE	APPROVED
8B 8D 8A	A	ALL	REVERSED CONN TO 6,11, & 7,10 OF S8441 FUNCTION "NINE". CHGD Q5 FROM 2N3711 TO 2N4418 ADDED ALTERNATE FOR Q1-5	2-17-67	
8B	B	SN.1 & ON	(ADDED C4, 5, 6 7PB BETWEEN PINS 10, 6, 2, & 4 B AND GND) INCORPORATED E.O. #1 CHANGE NO A.	4-13-67	

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

Q1-4 ALTERNATE : A-139, AMPEREX

Q5 ALTERNATE : 2N2368 T-1

REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

NOTES UNLESS [illegible]

37-2	37-2		
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

CON R. NO.

DRAWN	H. Newton	1-10-67
CHECK	[illegible]	2-18-67
APPR	[illegible]	2-10-67
RELEASE DATE		2-15-67

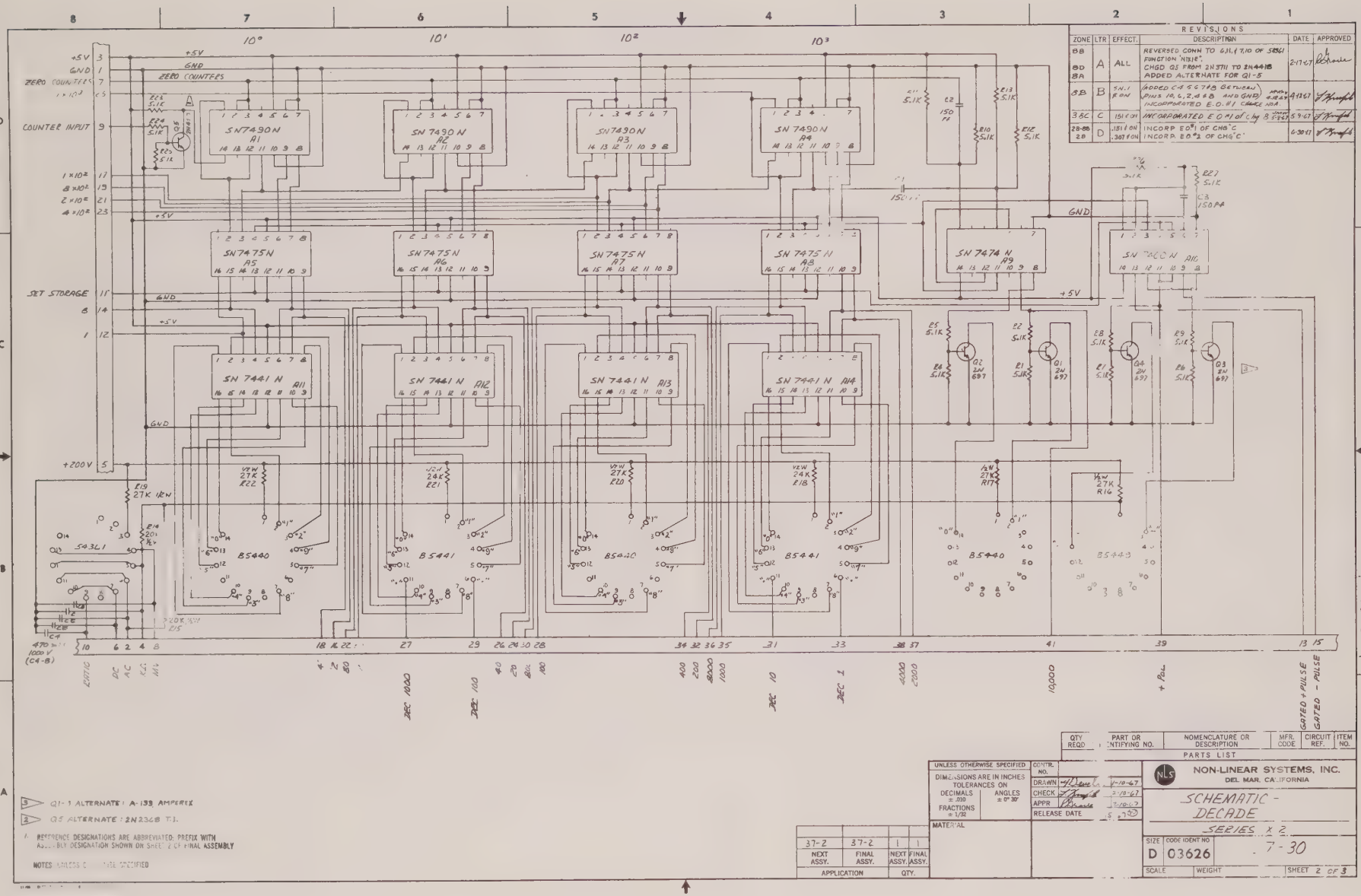
MATERIAL

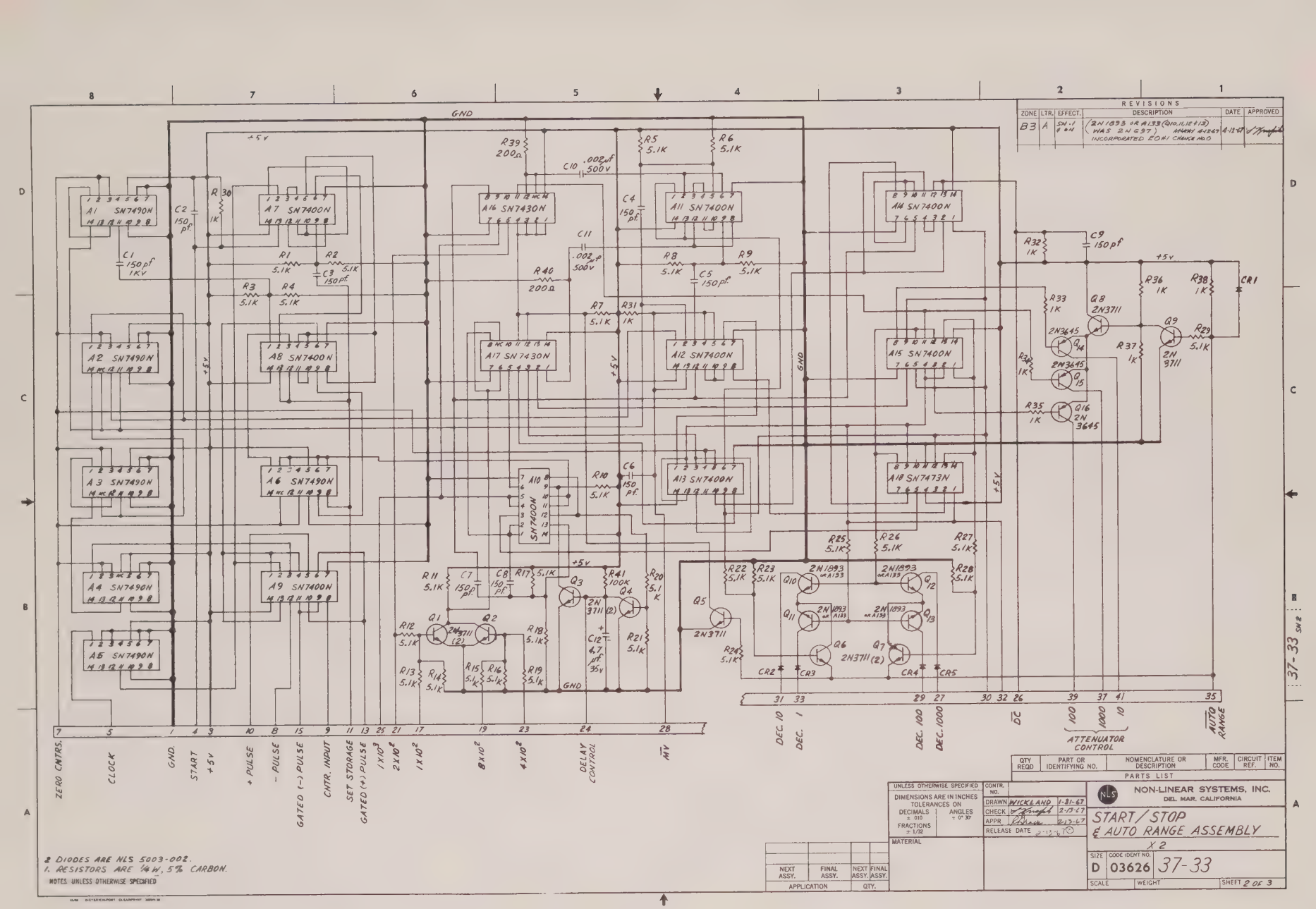
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC - DECADE
SERIES X-2

SIZE D | CONFIDENT NO 03626 | 37-30

SCALE | WEIGHT | SHEET 2 OF 3


REVISIONS
ZONE | LTR | EFFECT. | DESCRIPTION | DATE | APPROVED
8B | A | ALL | REVERSED CONN TO 6,11,(7,10 OF SN541 FUNCTION "NAND". CHGD Q5 FROM 2N3711 TO 2N4918 ADDED ALTERNATE FOR Q1-5 | 2-17-67
8D 8A
8B | B | S.N.1 & ON | (ADDED C-E 56 7 & 8 BETWEEN PINS 10, 6, 2, 4 & 8 AND GND) INCORPORATED E.O.#1 CHANGE 10A | MAY 4 1967 | 4-11-67
3&C | C | 151 & ON | INCORPORATED E O M 1 of Chg by B 5-9-67 | 5-9-67
28-88 2B | D | .151 & ON .307 & ON | INCORP. E.O.#1 OF CHG'C' INCORP. E.O.#2 OF CHG'C' | 6-30-67
+5V
GND
ZERO COUNTERS
COUNTER INPUT
1 x 10²
8 x 10²
2 x 10³
4 x 10³
SET STORAGE
+200V
SN7490N A1
SN7490N A2
SN7490N A3
SN7490N A4
SN7475N A5
SN7475N A6
SN7475N A7
SN7475N A8
SN7474N A9
SN7441N A11
SN7441N A12
SN7441N A13
SN7441N A14
B5440
B5441
B5443
54361
Q1-5 ALTERNATE: A-139 AMPEREX
Q5 ALTERNATE: 2N2368 T.I.
REFERENCE DESIGNATIONS ARE ABBREVIATED: PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
NOTES UNLESS OTHERWISE SPECIFIED
EXCITE
DC
AC
N.S.
MIN
REC 1000
REC 100
REC 10
REC 1
+ PULSE
GATED + PULSE
GATED - PULSE
QTY REQD | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MFR. CODE | CIRCUIT REF. | ITEM NO.
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS ± .010 ANGLES ± 0° 30' FRACTIONS ± 1/32
CONTR. NO.
DRAWN 7-10-67
CHECK 7-10-67
APPR 7-10-67
RELEASE DATE
MATERIAL
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
SCHEMATIC - DECADE SERIES X 2
SIZE D
CODE IDENT NO 03626
7-30
SCALE
WEIGHT
SHEET 2 OF 3
37-2 NEXT ASSY.
37-2 FINAL ASSY.
APPLICATION
QTY
37-30 rev



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
B3	A	SN-1 & ON	(2N1893 OR A133 (Q10,11,12 & 13) WAS 2N697) INCORPORATED ECR-1 CHANGE NO.0	4-13-67	

2 DIODES ARE NLS 5003-002.
1. RESISTORS ARE ¼W, 5% CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

CONTR. NO.		
DRAWN	WICKLAND	1-31-67
CHECK		2-13-67
APPR		2-13-67
RELEASE DATE		2-13-67

MATERIAL

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

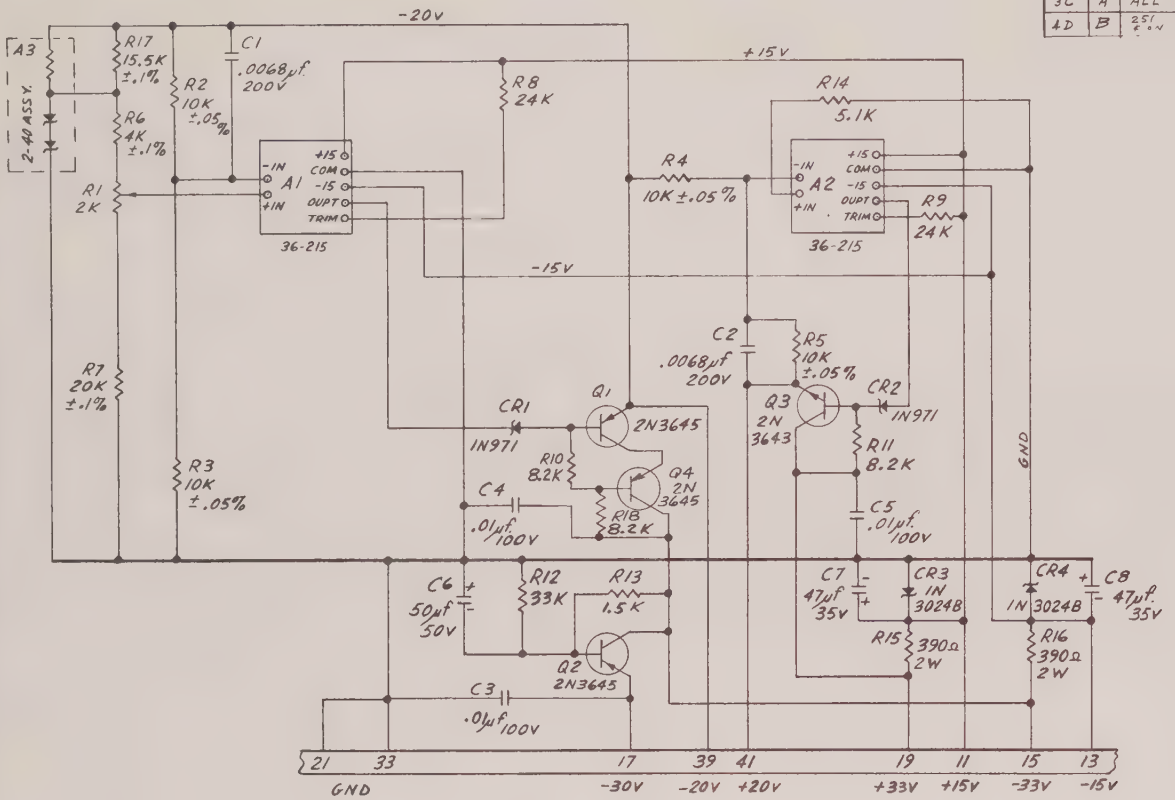
START / STOP & AUTO RANGE ASSEMBLY

X 2

SIZE	CODE IDENT NO.	
D	03626	37-33
SCALE	WEIGHT	SHEET 2 OF 3

37-33 SH 2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
3C	A	ALL	ADDED Q4 & R18 R.D.W.	4-25-67	RWT
4D	B	251 ECN	A3 (2-40 ASSY.) WAS 2-39 ASSY.	5-8-67	



37-36 SH2

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

2 RESISTORS R2 THRU R7 & R17 ARE NLS PW2016.

1. RESISTORS ARE 1/4 W, ±5%, CARBON.

NOTES. UNLESS OTHERWISE SPECIFIED

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
37-2	37-2	1	1
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

CONTR. NO.

DRAWN	WICKLAND	2-1-67
CHECK		2-16-67
APPR		2-16-67
RELEASE DATE		

MATERIAL

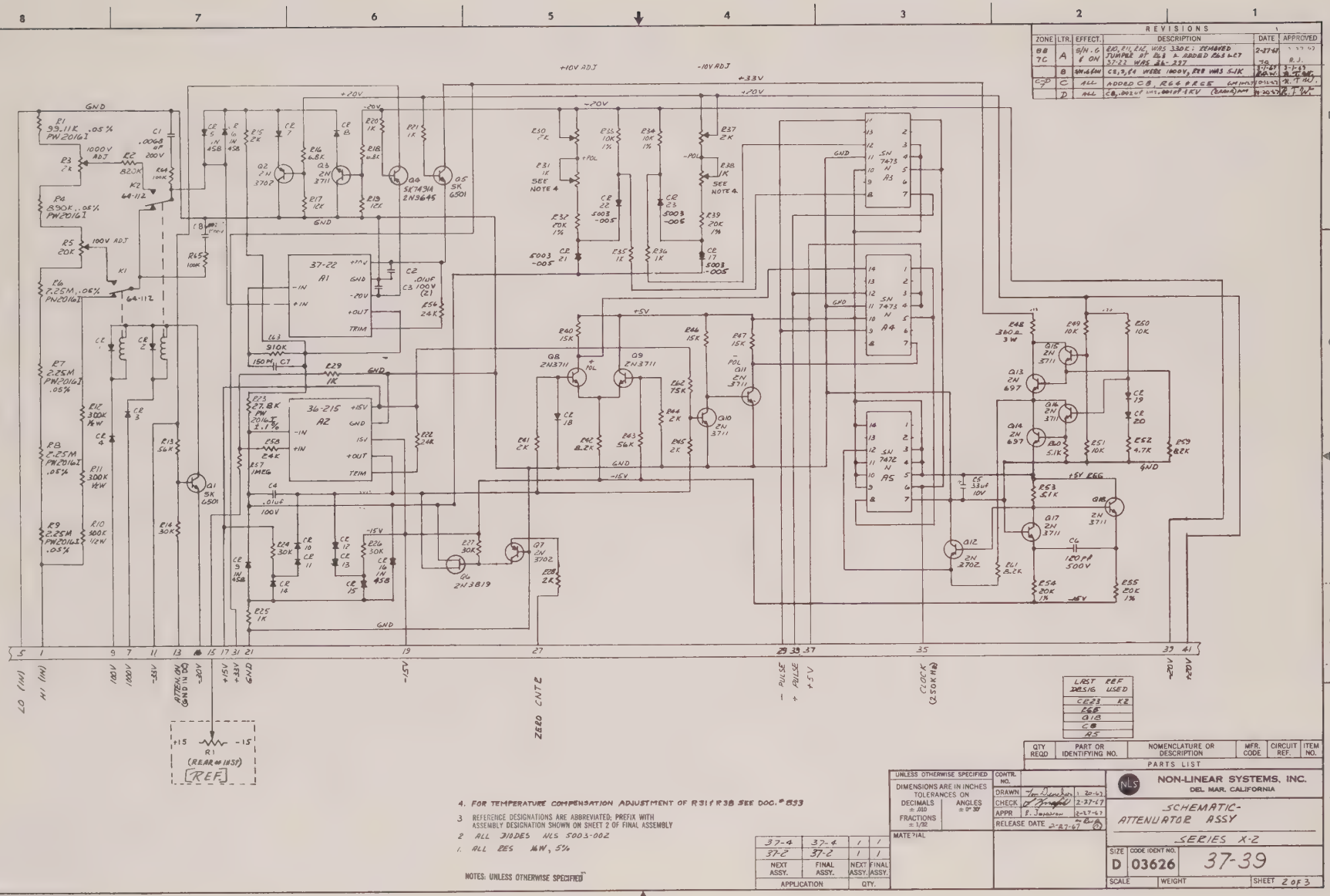
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

-SCHEMATIC-
REFERENCE ASSEMBLY
X2

SIZE	CODE IDENT NO.	
C	03626	37-36

SCALE | WEIGHT | SHEET 2 OF 3

8/66 DIETERICH POST CLEARPRINT 1000H 10



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
8B 7C	A	S/N 6 & ON	R20, R11, R21, WAS 330K; REMOVED JUMPER AT R21 & ADDED R65 WCT 37-22 WAS 24-237	2-27-67	B.J.
	B	S/N 4 & ON	C8, 9, 14 WERE 1000V, R28 WAS 5.1K	3-1-67	B.J.
C-D	C	ALL	ADDED C8, R64 P.R.E.	3-20-67	B.J.
	D	ALL	C8, 002 uf 1KV, 003 uf 1KV (BAND) ADD	4-20-67	B.J.

LAST DESIG	REF USED
CR23	K2
R68	
Q18	
C8	
A5	

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

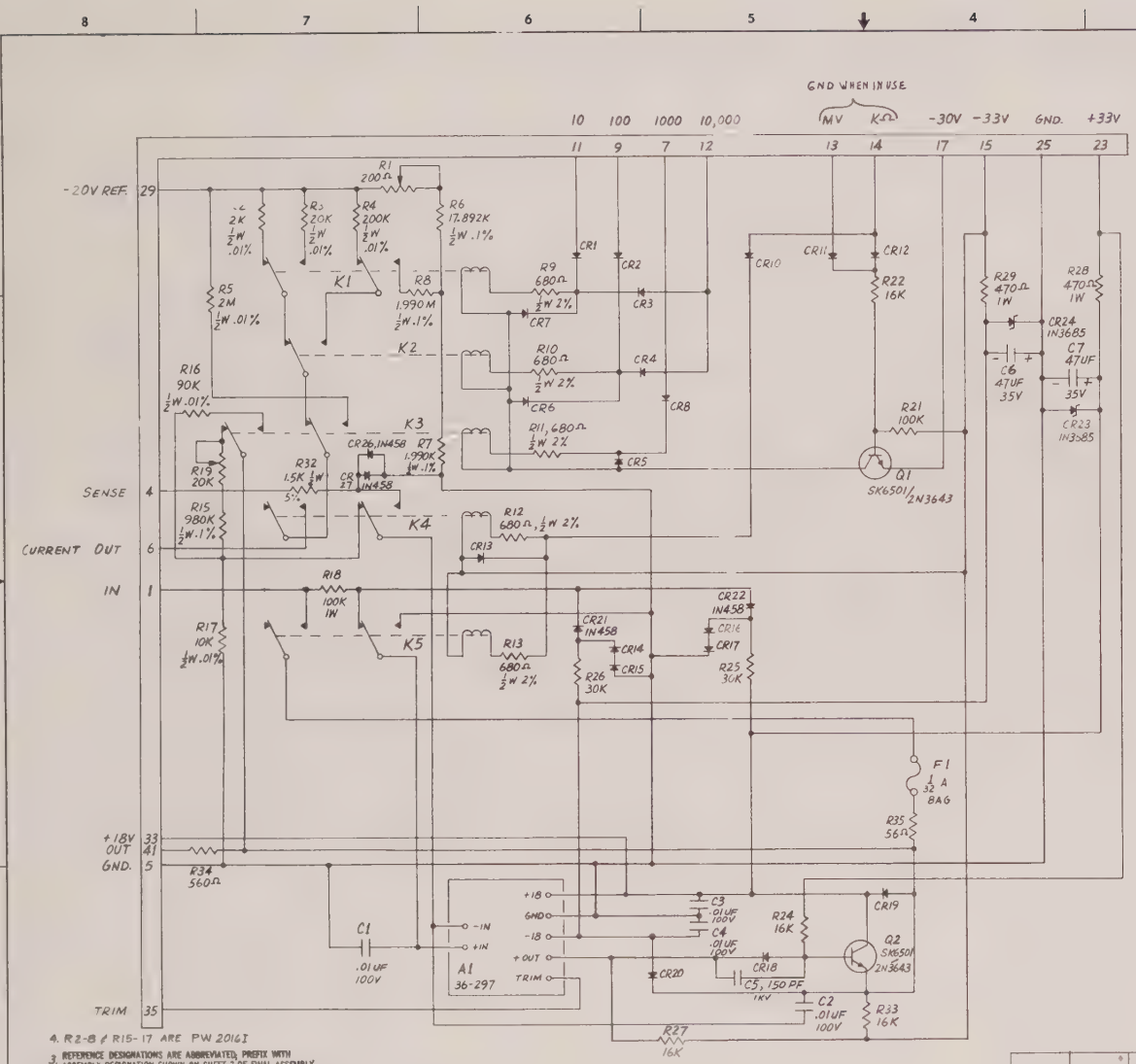
4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 / R38 SEE DOC. # 893
3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. ALL DIODES NLS 5003-002
1. ALL RES ¼W, 5%

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED	CONTR. NO.	NON-LINEAR SYSTEMS, INC. DEL MAR, CALIFORNIA
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .010 FRACTIONS ± 1/32 ANGLES ± 0° 30'	DRAWN T. Davidson 1-20-67	
	CHECK J. Bingham 2-27-67	SCHEMATIC- ATTENUATOR ASSY
	APPR B. Jonsson 2-27-67	SERIES X-2
MATERIAL	RELEASE DATE 2-27-67	SIZE D · CODE IDENT NO. 03626 · 37-39
		SCALE · WEIGHT · SHEET 2 OF 3

37-4	37-4	1	1
37-2	37-2	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

37-39 SH #2



OHMS RANGE RELAYS

RANGE	K1	K2	K3	K4	K5
1				X	X
10	X			X	X
100		X		X	X
1,000			X	X	X
10,000	X	X		X	X

LAST SYMBOL USED	
CAPACITOR	C7
DIODE	CR27
RESISTOR	R35

4. R2-8 & R15-17 ARE PW 2016I
3. REFERENCE DESIGNATIONS ARE ABBREVIATED, PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. DIODES ARE 5003-002.
1. RESISTORS ARE ¼W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

CONTR. NO
DRAWN H. BRINLEY 2-2-67
CHECK 3 28 67
APPR
RELEASE DATE 3-28-67

MATERIAL

NEXT ASSY. | FINAL ASSY. | NEXT ASSY | FINAL ASSY.
APPLICATION | QTY

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

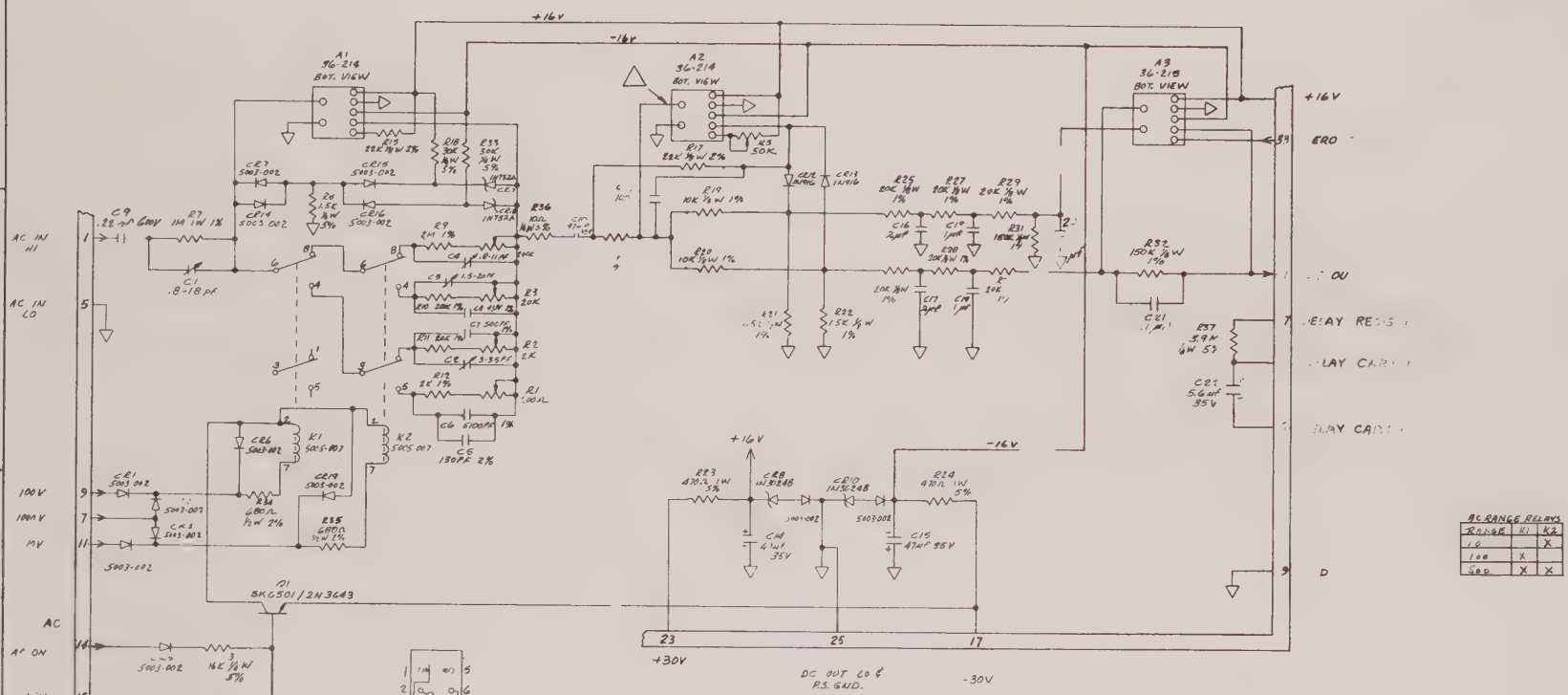
SCHEMATIC, PRE AMP & KΩ/DC CONVERTER

X2 SERIES

SIZE D | CODE IDENT NO. 03626 | 37-42

SCALE | WEIGHT | SHEET 2 OF 3

37-42 SH 2



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	A.R.N.	C16 & 17 (2MF/200V) WERE 1MF/250V	3-13-67	

AC RANGE RELAYS		
RANGE	K1	K2
10		X
100	X	
500	X	X

*CALIBRATION INSTRUCTIONS

PROC. NO.	RANGE	INPUT	ADJUST
1	1000V	0	ZERO PANEL CONTROL
	1000 V	500V 200 Z	R1
	1000 V	500V - 10K HZ	C1
4	100 V	100V - 200 HZ	R2
5	100 V	100V - 10K HZ	C2
6	10V	10V - 200 HZ	R3
7	10 V	10V - 10K HZ	C3
8	1 V	1V - 200 HZ	R4
9	1 V	1V - 10K HZ	C4

* ADJ HI RNG FIRST

△ THIS POINT SHOULD MEASURE 0V ± 1MV. IF NOT, ADJUST R5.

NOTES: UNLESS OTHERWISE SPECIFIED

REQD	IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES: DECIMALS ± .010, FRACTIONS ± 1/32, ANGLES ± 0° 30'

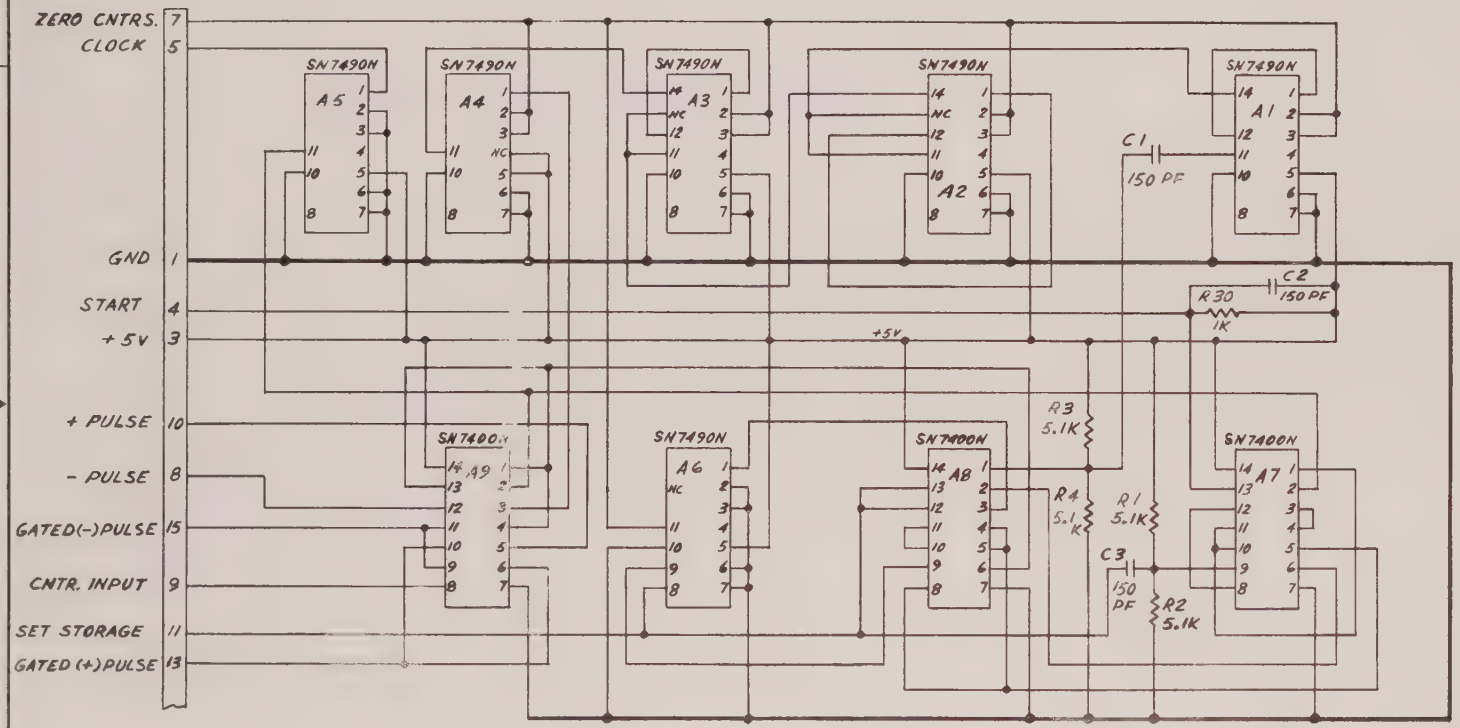
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

NONLINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
AC/DC CONVERTER
SERIES X2

SIZE	CODE IDENT. NO.	
D	03626	37-45
SCALE	WEIGHT	SHEET 2 OF 3

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
3B	A	ALL	CONNECTED A6-2,3,6,11 TO GND	2-17-67	



QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED	CONTR. NO.	
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .010 FRACTIONS ± 1/32 ANGLES ± 0° 30'	DRAWN	WICKLAND 2-3-67
	CHECK	2-13-67
	APPR	2-13-67
	RELEASE DATE	2-13-67
MATERIAL		

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

START STOP ASS'Y.

SERIES X2

SIZE	CODE IDENT NO.	
C	03626	37-69

SCALE | WEIGHT | SHEET 2 OF 3

37-2	37-2	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

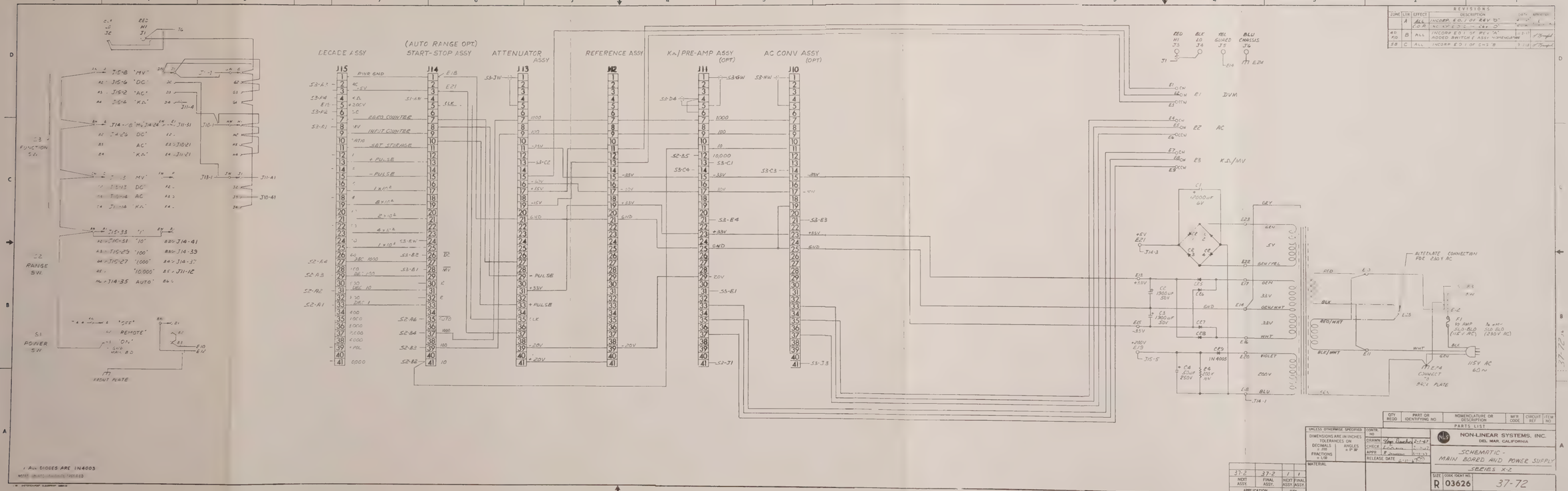
2. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

1. RESISTORS ARE 1/4 W, 5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

37-69 SH2

8/66 DIETERICH-POST CLEARPRINT 10004-10



REVISIONS

ZONE	LTR	EFFECT	DESCRIPTION	BY	APPROVED
	A	ECR C.O.R	INCORP. E.O.1 OF REV "D" AS MFG'D — REV "E"	[illegible]	[illegible]
4D 7D	B	ALL	INCORP E.O.1 OF REV "E" ADDED SWITCH ∈ ASSY NOMENCLATURE	[illegible]	[illegible]
3B	C	ALL	INCORP E.O.1 OF CH'G 'B'	[illegible]	[illegible]

PARTS LIST

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF	ITEM NO.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .005 FRACTIONS ± 1/32 ANGLES ± 0° 30'

CONTR NO. | DRAWN Tom Dunckley 2-1-67 | CHECK | APPR. [illegible] | RELEASE DATE 6-12-67

MATERIAL

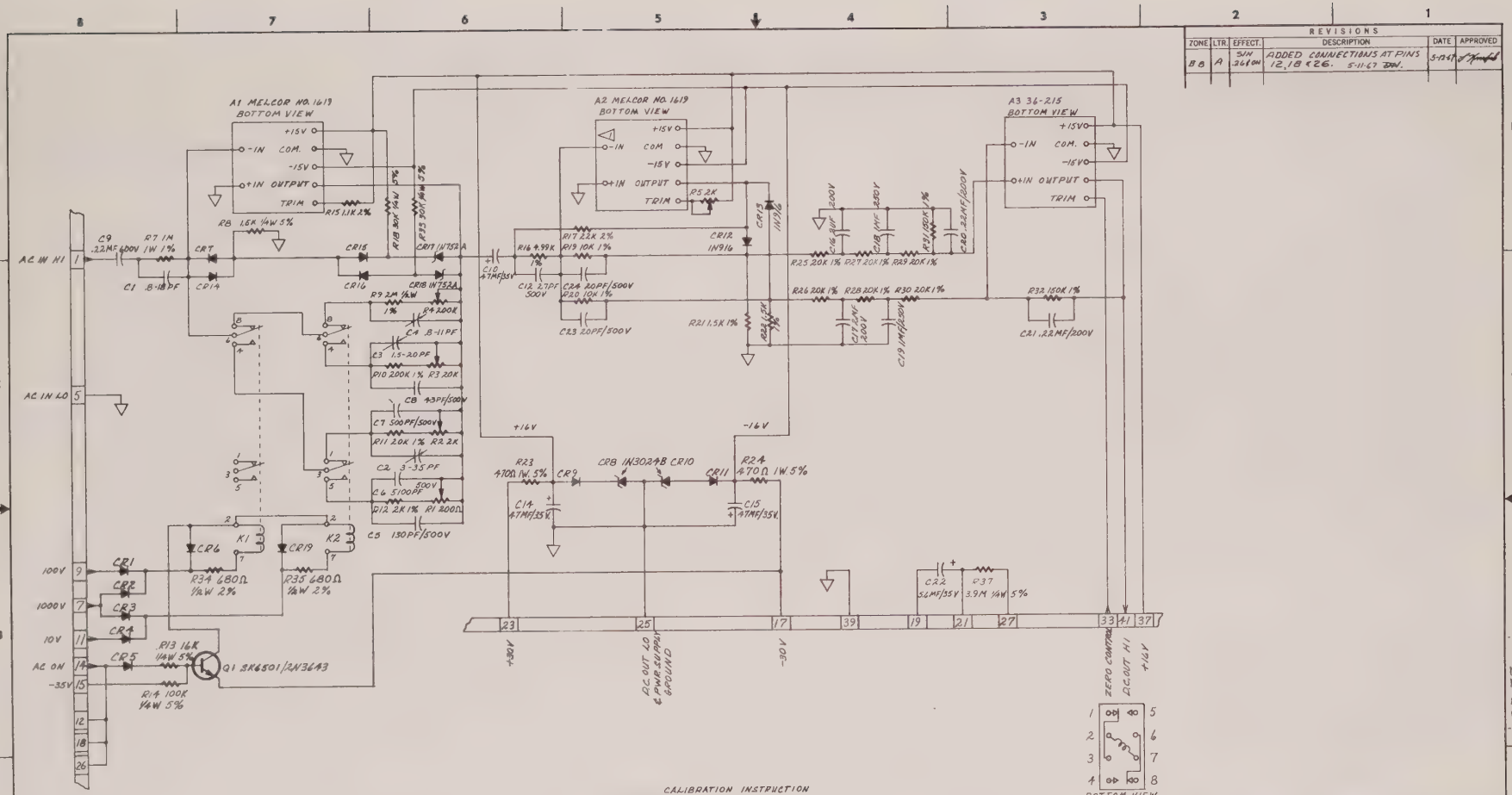
NON-LINEAR SYSTEMS, INC. DEL MAR, CALIFORNIA

SCHEMATIC - MAIN BOARD ASSY POWER SUPPLY SERIES X-Z

SIZE	CODE IDENT NO.	DWG NO.	REV
R	03626	37-72	

SCALE None | WEIGHT | SHEET 2 of 3

37-2 NEXT ASSY	37-2 FINAL ASSY	1 NEXT ASSY	1 FINAL ASSY
APPLICATION		QTY	



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
B8	A	SW 3268ON	ADDED CONNECTIONS AT PINS 12, 18 & 26. 5-11-67 JDW.	5-12-67	

CALIBRATION INSTRUCTION

PROCEDURE NO.	RANGE	INPUT	ADJUST (REAR PANEL CONTROL FOR AC OFFSET)
1	1000V	0	
2	1000 V	500V - 200 HZ	R1
3	1000 V	500V - 80KHZ	C1
4	100V	100V - 200 HZ	R2
5	100V	100V - 80KHZ	C2
6	10V	10V - 200HZ	R3
7	10V	10V - 80KHZ	C3
8	1V	1V - 200 HZ	R4
9	1V	1V - 80KHZ	C4

6. ALL RELAYS ARE 5005-007
5. ALL RESISTORS ARE ½ W
4. ALL DIODES ARE 145 3003-002
3. AFTER CALIBRATION, SPOT CHECK AT VARIOUS FREQUENCIES THROUGHOUT BAND WIDTH OF CONVERTER.
2. REFERENCE DESIGNATIONS ARE ABBREVIATED: PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
1. THIS POINT SHOULD MEASURE 0V ± 1MV. ADJUST R5 FOR CORRECTION.

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

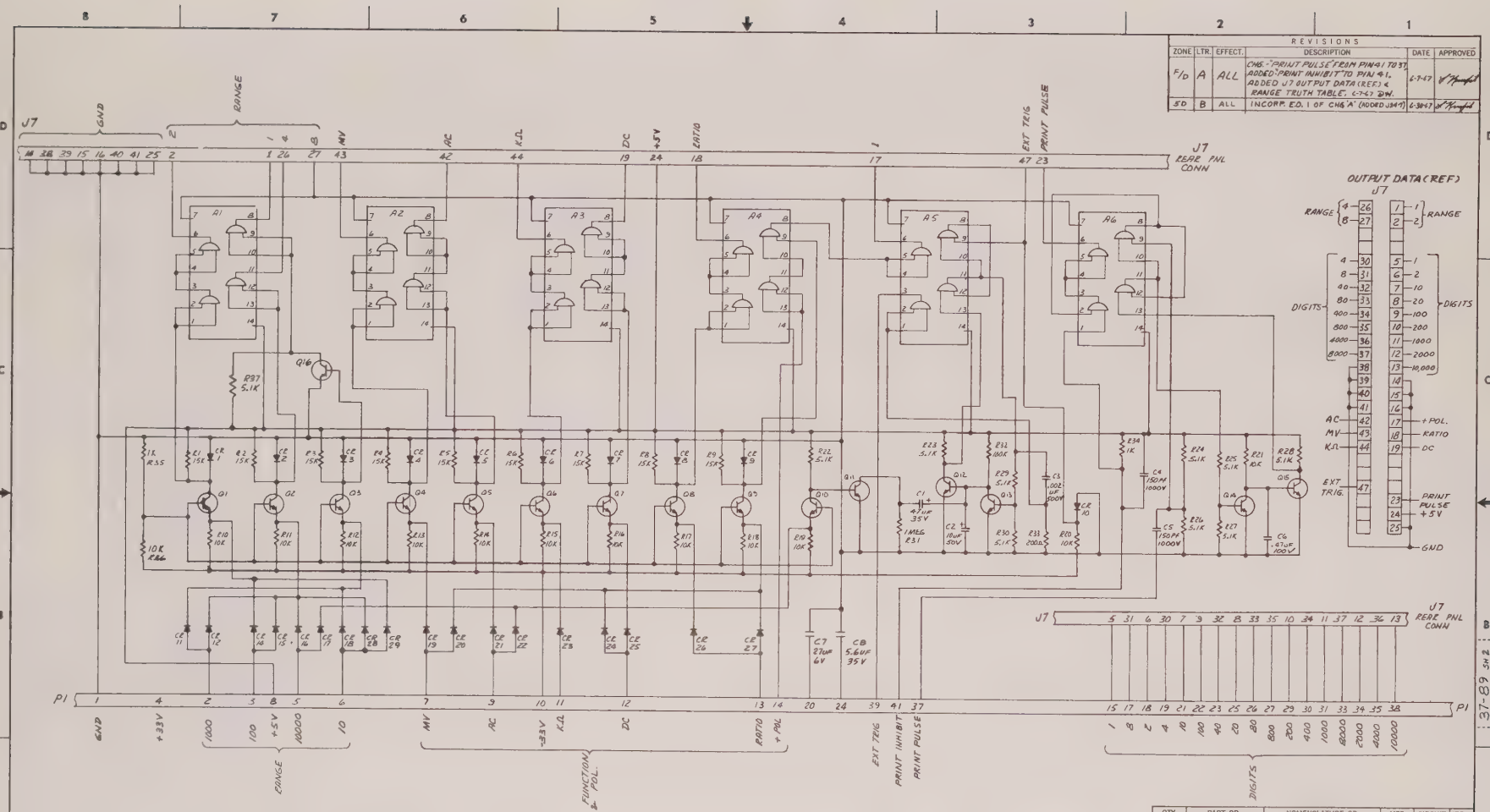
CONTR. NO.		
DRAWN	J.A. COMB 3	3-16-67
CHECK		3-27-67
APPR	E. Jamison	3-28-67
RELEASE DATE	3-28-67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
100KHZ AC/DC CONVERTER
SERIES X-2

SIZE	CODE IDENT NO.	
D	03626	37-77
SCALE	WEIGHT	SHEET 2 OF 3

37-77 SH 2

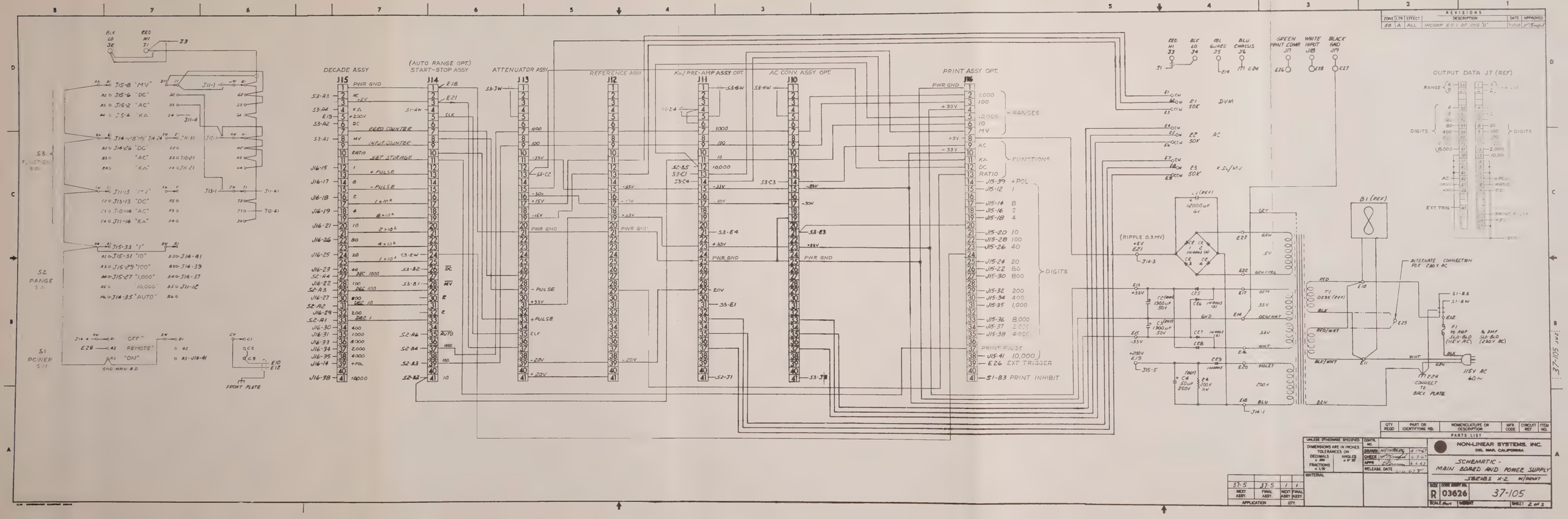


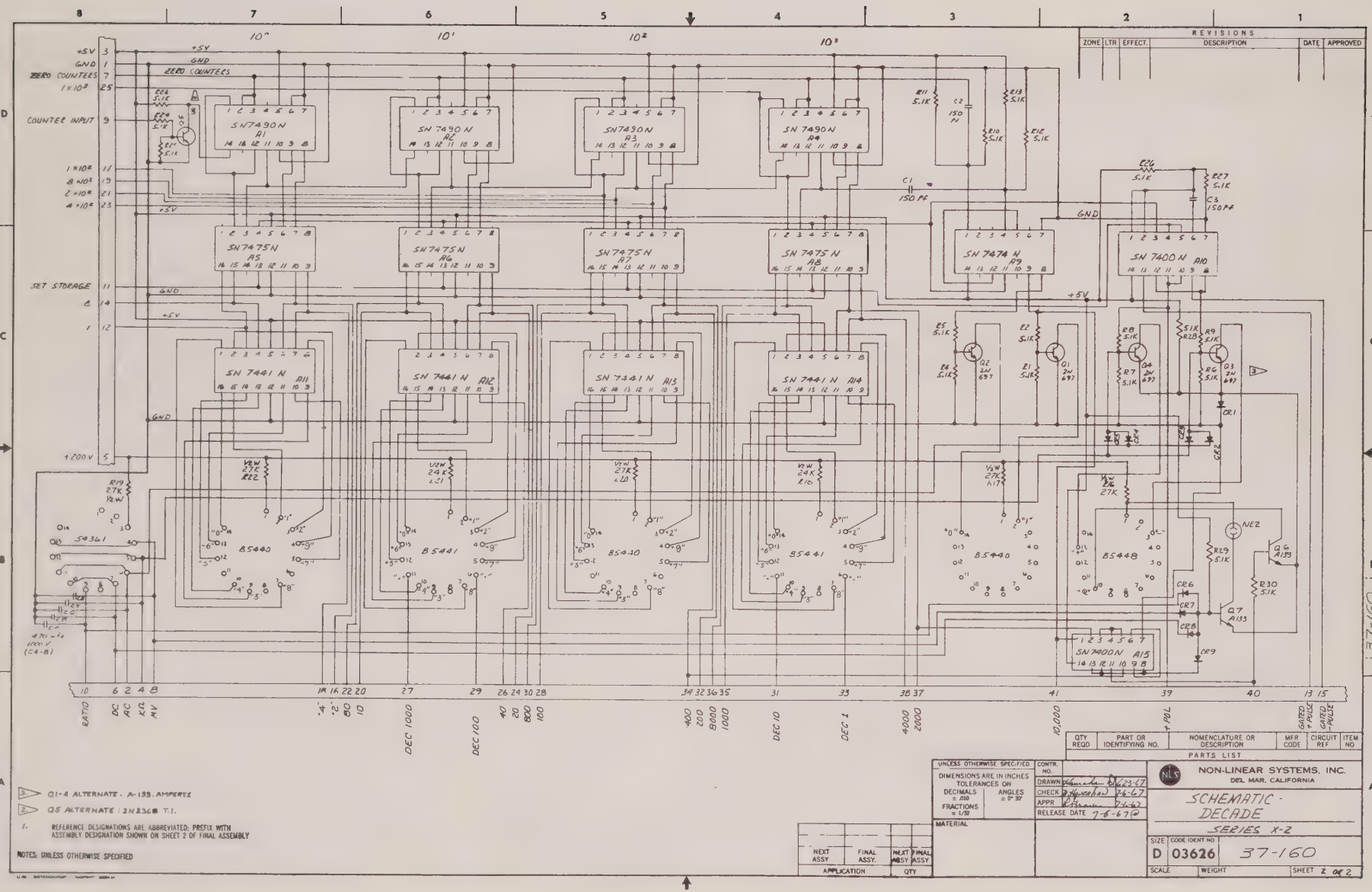
REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
F/D	A	ALL	CHG. "PRINT PULSE" FROM PIN 41 TO 37, ADDED "PRINT INHIBIT" TO PIN 41, ADDED J7 OUTPUT DATA (REF.) & RANGE TRUTH TABLE. C-7-67 DW.	6-7-67	
5D	B	ALL	INCORP. E.O. 1 OF CHG 'A' (ADDED J347)	6-30-67	

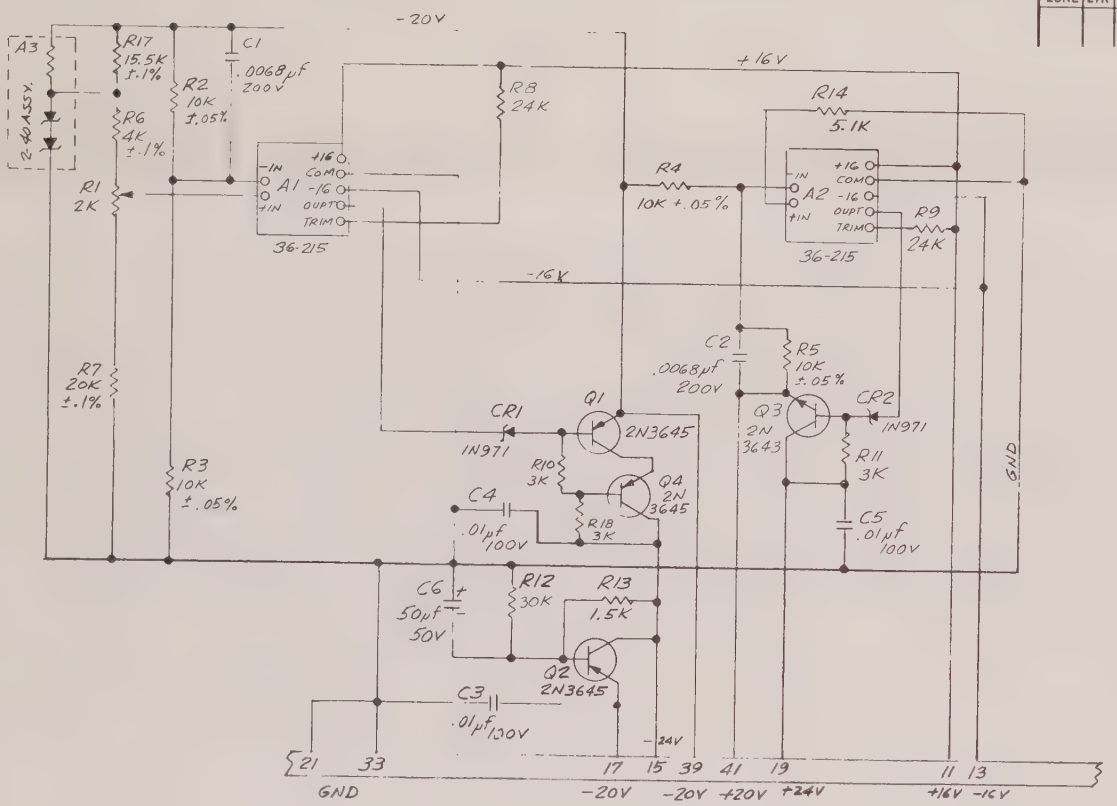
PARTS LIST					
QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

UNLESS OTHERWISE SPECIFIED	CONTR. NO.	NON-LINEAR SYSTEMS, INC. DEL MAR, CALIFORNIA	
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .010 FRACTIONS ± 1/32 ANGLES ± 0° 30'	DRAWN H. Wenker 3/31/67	ASSY, PRINT BOARD SCHEMATIC	
	CHECK [illegible] 5-1-67		
	APPR [illegible] 5-5-67		
MATERIAL	RELEASE DATE 5-5-67	SERIES X-2	
37-5 NEXT ASSY. / 37-5 FINAL ASSY. / 1 NEXT ASSY / 1 FINAL ASSY	APPLICATION / QTY.	SIZE D / CODE IDENT NO. 03626 / 37-89	
		SCALE / WEIGHT / SHEET 2 OF 3	

37-89 SH 2


DECADE ASSY
(AUTO RANGE OPT.) START-STOP ASSY
ATTENUATOR ASSY
REFERENCE ASSY
K$_M$ PRE-AMP ASSY OPT.
AC CONV. ASSY OPT.
PRINT ASSY OPT.
J15
J14
J13
J12
J11
J10
J16
PWR GND
RANGES
FUNCTIONS
DIGITS
PRINT PULSE
S1-83 PRINT INHIBIT
E26 EXT TRIGGER
S3 FUNCTION
S2 RANGE
S1 POWER
OUTPUT DATA J7 (REF)
REVISIONS
ZONE | LTR | EFFECT | DESCRIPTION | DATE | APPROVED
BB | A | ALL | INCORP E.O.I. OF CHG 'G' | 3-10-68
PARTS LIST
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
SCHEMATIC -
MAIN BOARD AND POWER SUPPLY
SBCABS X-Z W/PRINT
DRAWN WITNEBEY 4-19-67
CHECK 4-5-67
APPR 6-6-67
RELEASE DATE 6-16-67
SIZE R
CODE IDENT NO. 03626
DRAWING NO. 37-105
SCALE None
WEIGHT
SHEET 2 OF 2
37-105 sht 2
37-5 NEXT ASSY
37-5 FINAL ASSY
1 NEXT FINAL ASSY
1 QTY.
APPLICATION


REVISIONS
ZONE | LTR | EFFECT. | DESCRIPTION | DATE | APPROVED
+5V
GND
ZERO COUNTERS
COUNTER INPUT
SET STORAGE
+200 V
SN7490N A1
SN7490N A2
SN7490N A3
SN7490N A4
SN7475N A5
SN7475N A6
SN7475N A7
SN7475N A8
SN7441N A11
SN7441N A12
SN7441N A13
SN7441N A14
SN7474N A9
SN7400N A10
SN7400N A15
Q1 2N697
Q2 2N697
Q3 2N697
Q4 2N697
Q5 A133
Q6 A133
Q7 A133
NE2
B5440
B5441
B5448
RATIO
DC
AC
KD
NV
DEC 1000
DEC 100
DEC 10
DEC 1
4000
2000
10,000
+ PAL
GATED + PULSE
GATED - PULSE
Q1-4 ALTERNATE : A-133, AMPERITE
Q5 ALTERNATE : 2N2368 T-1.
1. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
NOTES: UNLESS OTHERWISE SPECIFIED
QTY REQD | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MFR CODE | CIRCUIT REF | ITEM NO
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
CONTR. NO.
DRAWN 6/22-67
CHECK 7-6-67
APPR 7-6-67
RELEASE DATE 7-6-67
MATERIAL
NEXT ASSY | FINAL ASSY | NEXT MSY ASSY | FINAL MSY ASSY
APPLICATION | QTY
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
SCHEMATIC - DECADE
SERIES X-2
SIZE D | CODE IDENT NO 03626 | 37-160
SCALE | WEIGHT | SHEET 2 of 2
37-160 SHT 2



REVISIONS					
ZONE	LTR	EFFECT.	DESCRIPTION	DATE	APPROVED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. RESISTORS R2 THRU R7 & R17 ARE NLS PW2016
1. RESISTORS ARE 1/4 W, ±5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
37-272	37-98	1	1
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.

DRAWN	McKay	10-14-67
CHECK	Watkins	10-20-67
APPR	R.T. McManus	10-20-67
RELEASE DATE	10-23-67 pc	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

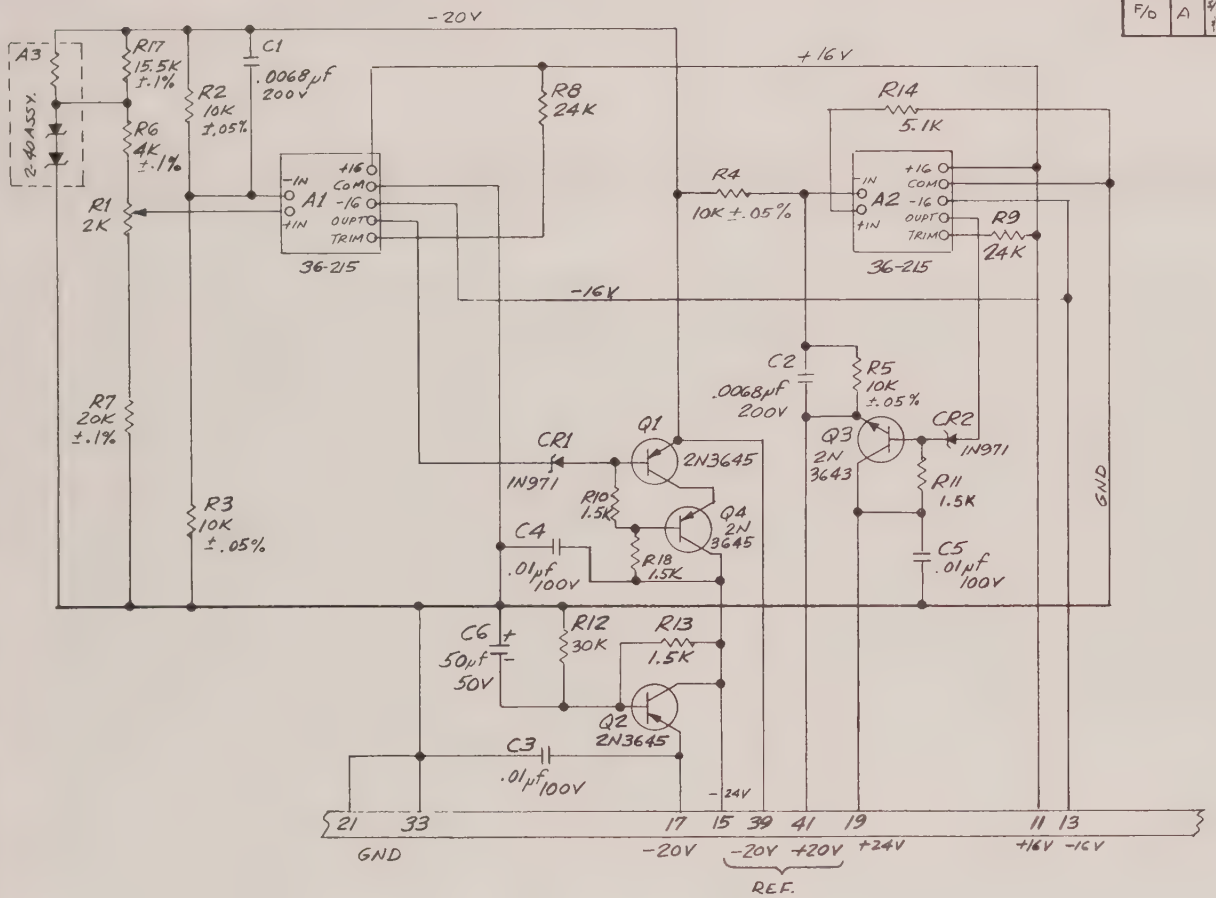
SCHEMATIC
REFERENCE ASSEMBLY
X-2

SIZE	CODE IDENT NO.	
C	03626	37-272

SCALE — WEIGHT SHEET 2 of 2

37-272 SH2

8/68 DIETERICH-POST CLEARPRINT 1000H-10



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
F/O	A	4N.543 1 ON	INCORP E.O. 1 of CHG "O" & R11 WAS 3K 2-1-68 DM	2-1-68	

37-272 SH2

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED	CONTR. NO.		
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ±.010 ANGLES ± 0° 30' FRACTIONS ± 1/32	DRAWN	McKay	10-14-67
	CHECK	Watkins	10-20-67
	APPR	R. T. Watkins	10-20-67
	RELEASE DATE	10-23-67	
MATERIAL			

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
REFERENCE ASSEMBLY
X-2

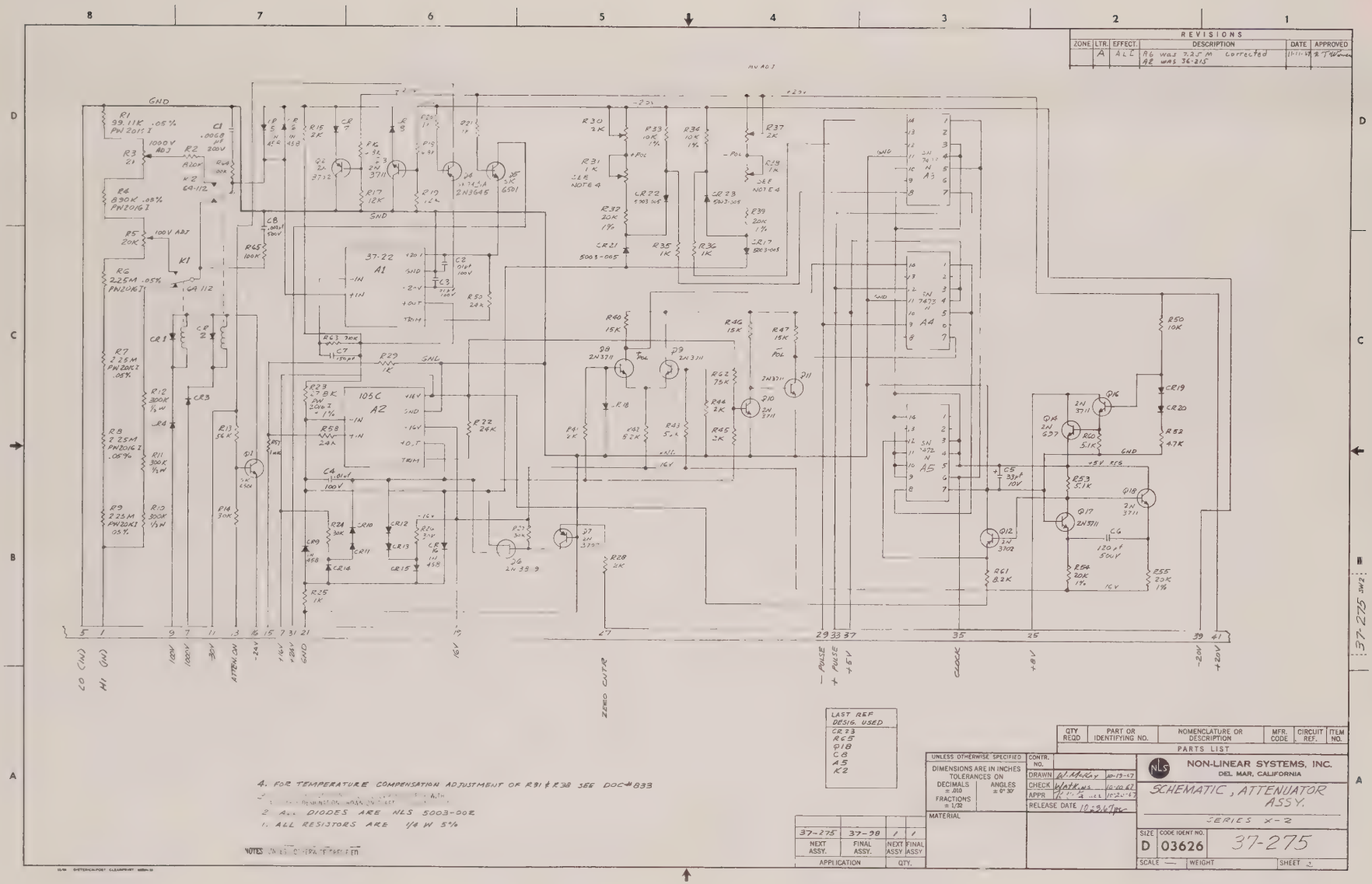
SIZE	CODE IDENT NO.	
C	03626	37-272
SCALE —	WEIGHT	SHEET 2 OF 2

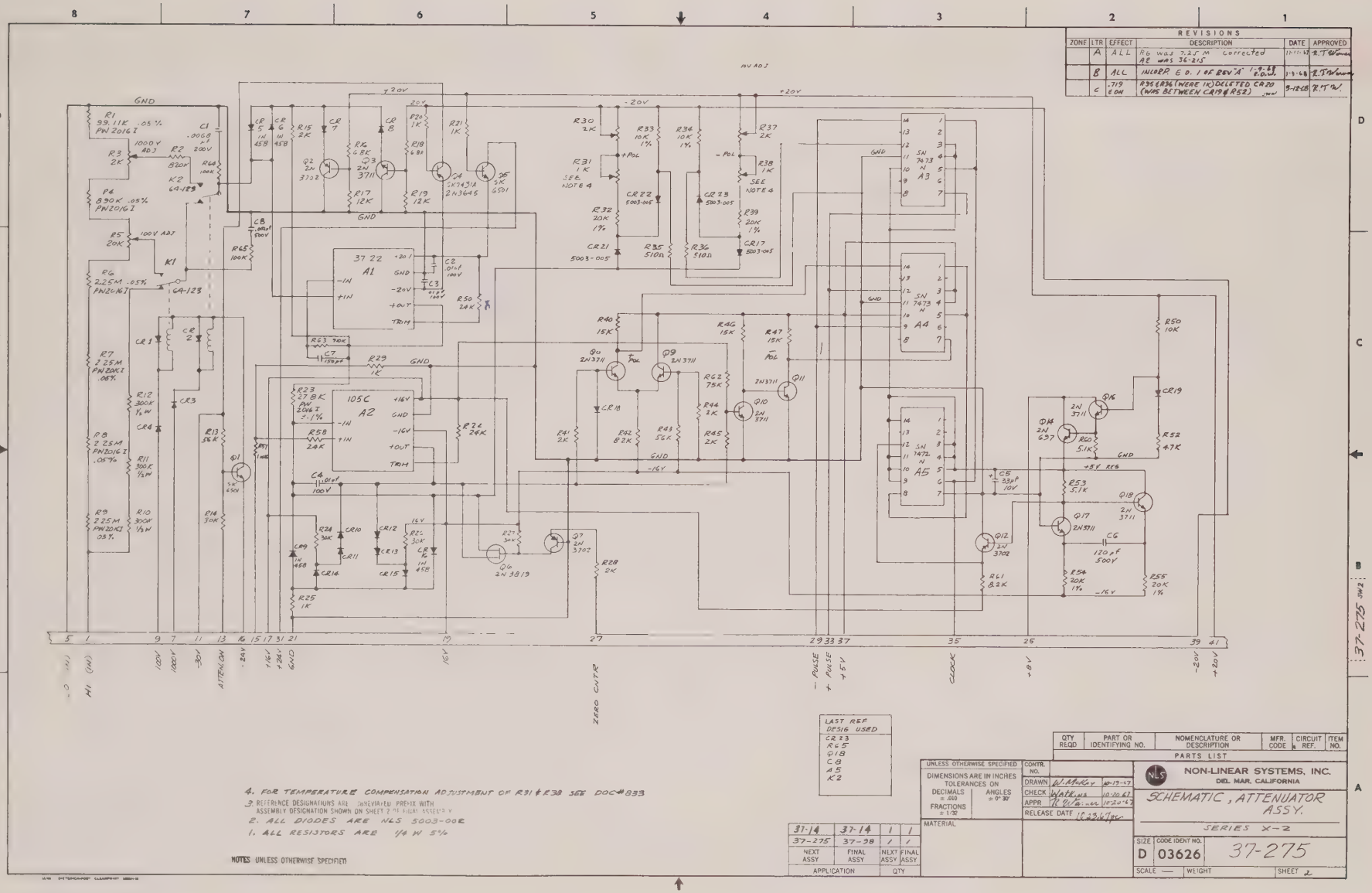
37-14	37-14	1	1
37-272	37-98	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

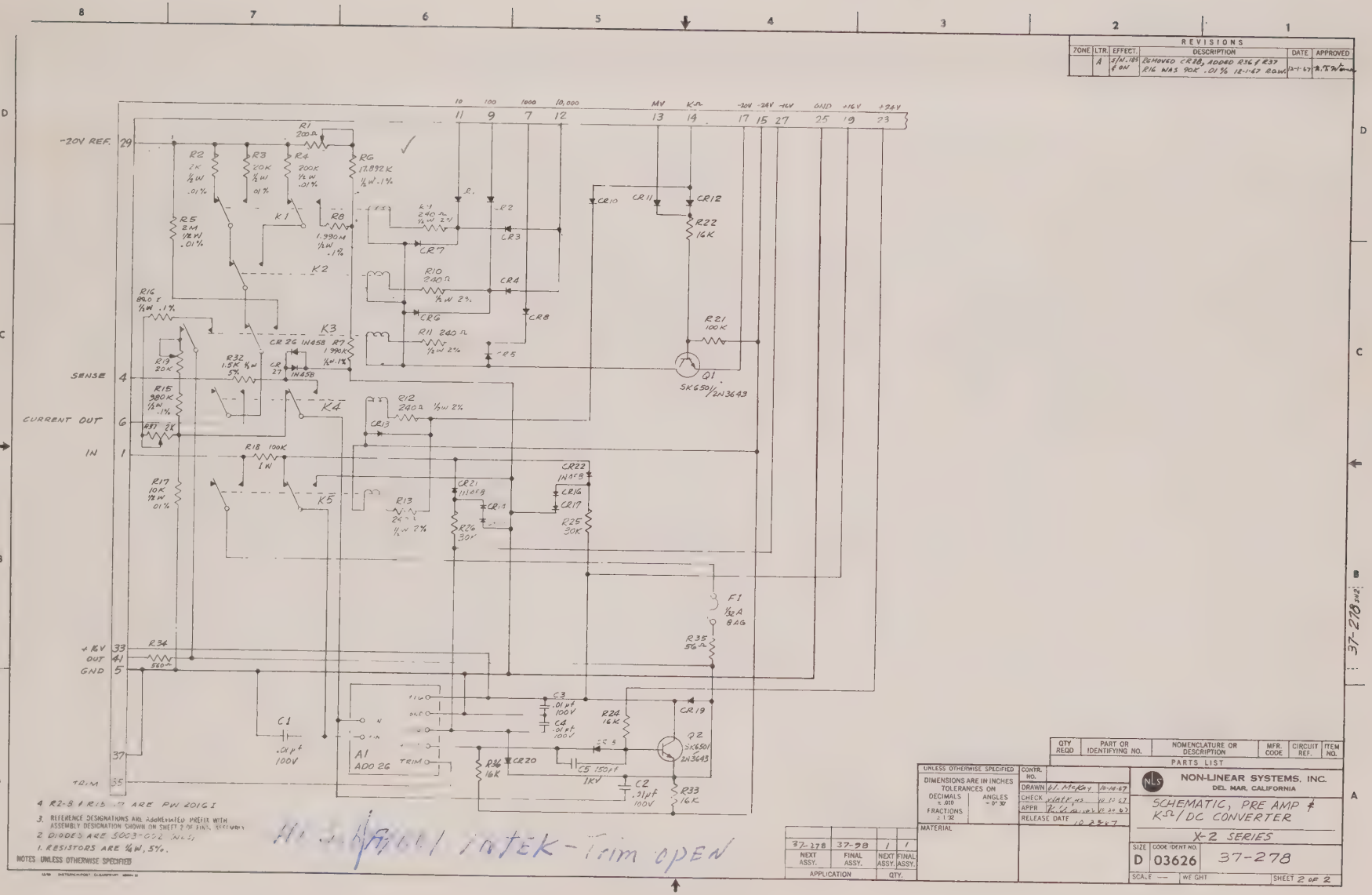
3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2 RESISTORS R2 THRU R7 & R17 ARE NLS PW2016
1. RESISTORS ARE 1/4 W; ±5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

8/66 DIETERICH-POST CLEARPRINT 1000M-10


REVISIONS
ZONE | LTR. | EFFECT. | DESCRIPTION | DATE | APPROVED
A | ALL | R6 was 7.25 M corrected AR was 36-215
GND
+23V
-23V
R1 99.11K .05% PWZ011
R2 1000V ADJ A20K
R3 21
R4 690K .08% PWZ016
R5 20K 100V ADJ
R6 225M .05% PWZ016
R7 225M PWZ011 .05%
R8 225M PWZ016 .05%
R9 225M PWZ013 .05%
R11 300K 1/2W
R12 300K 1/2W
R13 56K
R14 300K
R15 2K
R17 12K
R19 1.2K
R20 2K
R21 1K
R22 1K
R23 7.87K PW 20W 1%
R24 30K
R25 1K
R26 30K
R27 30K
R28 2K
R29 1K
R30 2K
R31 1K SEE NOTE 4
R32 20K 1%
R33 10K 1%
R34 10K 1%
R35 1K
R36 1K
R37 2K
R38 1K SEE NOTE 4
R39 20K 1%
R40 15K
R41 2K
R42 5.2K
R43 5.2K
R45 2K
R46 15K
R47 15K
R48 75K
R50 10K
R52 4.7K
R53 5.1K
R54 20K 1%
R55 20K 1%
R61 8.2K
R65 100K
R58 20K
R59 1K
R60 1K
C1 .0008 µf 200V
C2 .01µf 100V
C3 .01µf 100V
C4 .01µf 100V
C5 33µf 10V
C6 120µf 50V
C7 150pf
C8 .0015µf 100V
CR1
CR2
CR3
CR7
CR8
CR9 1N 458
CR10
CR11
CR12
CR13
CR14
CR15
CR16 1N 458
CR18
CR19
CR20
CR21 5003-005
CR22 5003-005
CR23 5003-005
K1 GA 112
K2 GA 112
37-22 A1
105C A2
SN 7473 N A3
SN 7473 N AA
SN 7473 N AB
Q1 2N 4304
Q2 2N 3732
Q3 2N 3711
Q4 2N 3711
Q5 2N 3711
Q6 2N 3711
Q7 2N 3707
Q8 2N 3711
Q9 2N 3711
Q10 2N 3711
Q11 2N 3711
Q12 2N 3702
Q13 2N 5237
Q16 2N 3711
Q17 2N 3711
Q18 2N 3711
LO (LW)
HI (HW)
100V
1000V
-30V
ATTEN. ON
-24V
+16V
+28V
GND
+16V
ZERO CUTP
-PULSE
+PULSE
+5V
CLOCK
+8V
-20V
+20V
LAST REF DESIG. USED
CR23
R65
Q18
C8
A5
K2
4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 & R38 SEE DOC#833
2 ALL DIODES ARE NLS 5003-002
1. ALL RESISTORS ARE 1/4 W 5%
QTY REQD | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MFR. CODE | CIRCUIT REF. | ITEM NO.
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
CONTR. NO.
DRAWN R.I. Mabry 10-13-67
CHECK W. Mathews 10-20-67
APPR 10-22-67
RELEASE DATE 10-23-67
MATERIAL
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
SCHEMATIC, ATTENUATOR ASSY.
SERIES X-2
37-275 | 37-98 | 1 | 1
NEXT ASSY. | FINAL ASSY. | NEXT ASSY | FINAL ASSY.
APPLICATION | QTY.
SIZE D | CODE IDENT NO. 03626 | 37-275
SCALE — | WEIGHT | SHEET 2
37-275 REV


REVISIONS
ZONE | LTR | EFFECT | DESCRIPTION | DATE | APPROVED
A | ALL | R6 was 7.25 M corrected A2 was 36-215 | 11-11-67 | R.T.W.
B | ALL | INCORP E.O. 1 OF REV A 1-9-68 E.O.W. | 1-9-68 | R.T.W.
C | .719 60W | R36 & R36 (WERE IK) DELETED CR20 (WAS BETWEEN CR19 & R52) | 5-12-68 | R.T.W.
GND
+20V
-20V
+5V REG
-16V
+16V
+24V
-24V
ATTENUATION
ZERO CNTR
CLOCK
- PULSE
+ PULSE
+5V
+8V
A1
A2
A3
A4
A5
K1
K2
LAST REF DESIG USED
CR23
R65
Q18
C9
A5
K2
4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 & R38 SEE DOC# 833
3. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. ALL DIODES ARE NLS 5003-005
1. ALL RESISTORS ARE 1/4 W 5%
NOTES UNLESS OTHERWISE SPECIFIED
QTY REQD | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MFR. CODE | CIRCUIT REF. | ITEM NO.
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS ± .010 FRACTIONS ± 1/32 ANGLES ± 0° 30'
CONTR NO.
DRAWN W. Markey 10-19-67
CHECK Watkins 10-20-67
APPR R.T.W. 10-20-67
RELEASE DATE 10-23-67
MATERIAL
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
SCHEMATIC, ATTENUATOR ASSY.
SERIES X-2
SIZE D | CODE IDENT NO. 03626 | 37-275
SCALE — | WEIGHT | SHEET 2
37-14 | 37-14 | 1 | 1
37-275 | 37-38 | 1 | 1
NEXT ASSY | FINAL ASSY | NEXT ASSY | FINAL ASSY | QTY
APPLICATION
37-275 SH 2



4. R2-8 & R15-17 ARE PW 2016 I
3. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF 2 (S.S. SECONDARY)
2. DIODES ARE 5083-0512 (N.L.)
1. RESISTORS ARE 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

Hi-Z/Gnd/Intek - Trim open

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	4/W.1% & 8W	REMOVED CR18, ADDED R36 & R37 R16 WAS 90K .01% 12-11-67 20W	12-1-67	

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

CONTR. NO.
DRAWN V.J. McKay 10-14-67
CHECK [illegible] 12-1-67
APPR [illegible] 12-20-67
RELEASE DATE 12-23-67
MATERIAL

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC, PRE AMP & K-Ω/DC CONVERTER

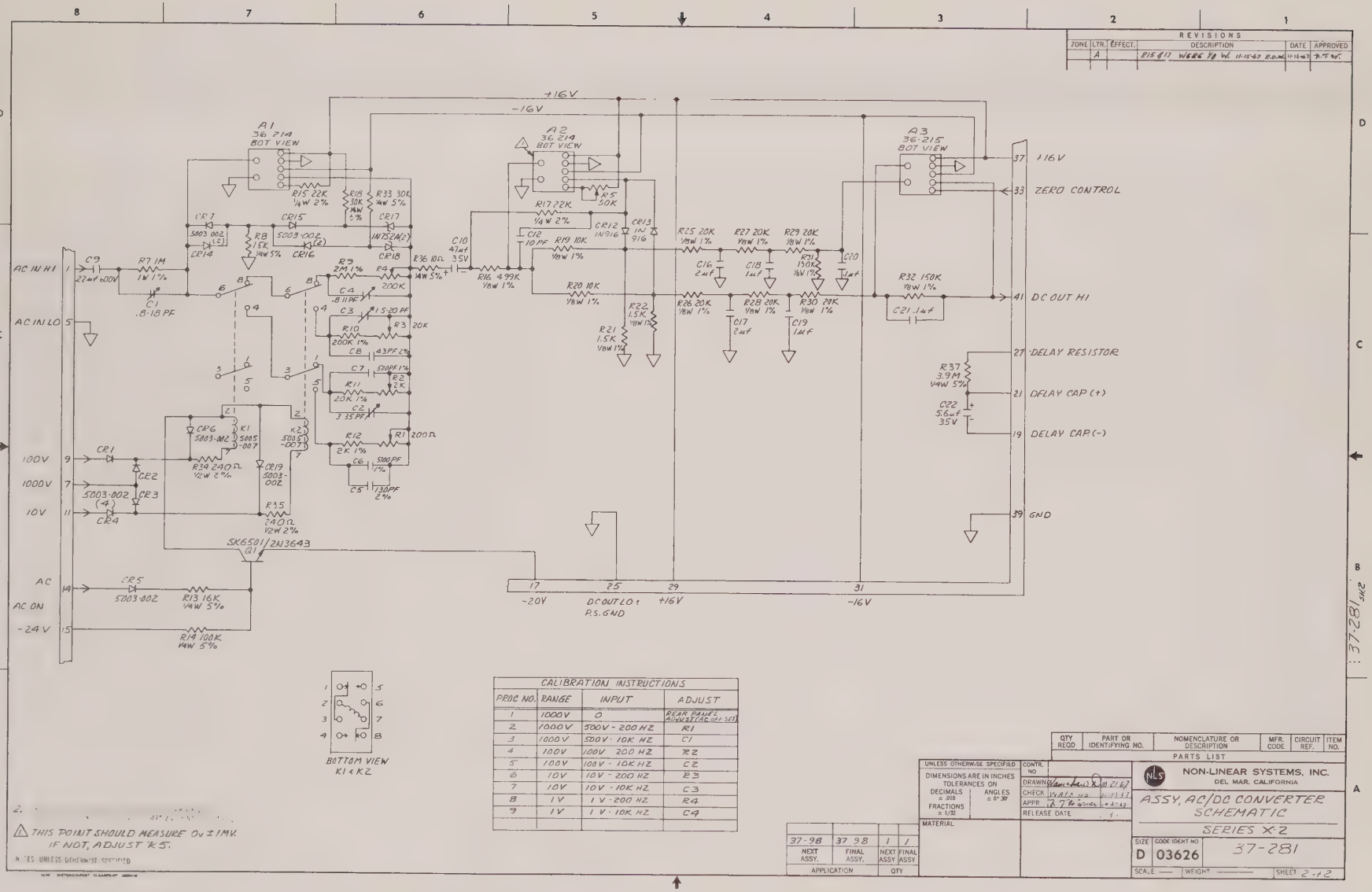
X-2 SERIES

SIZE	CODE IDENT NO.	
D	03626	37-278

SCALE — WEIGHT SHEET 2 OF 2

37-278 NEXT ASSY.	37-38 FINAL ASSY.	1 NEXT ASSY.	1 FINAL ASSY.
APPLICATION		QTY.	

37-278 sht 2



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A		ECR #17 WERE Y8 W. 11-15-67 R.D.M.	11-16-67	J.T.W.

CALIBRATION INSTRUCTIONS

PROC NO.	RANGE	INPUT	ADJUST
1	1000V	0	REAR PANEL ADJUST (AC OFF SET)
2	1000V	500V - 200 HZ	R1
3	1000V	500V - 10K HZ	C1
4	100V	100V 200 HZ	R2
5	100V	100V - 10K HZ	C2
6	10V	10V - 200 HZ	R3
7	10V	10V - 10K HZ	C3
8	1V	1V - 200 HZ	R4
9	1V	1V - 10K HZ	C4

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

37-98	37 98	/	/
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

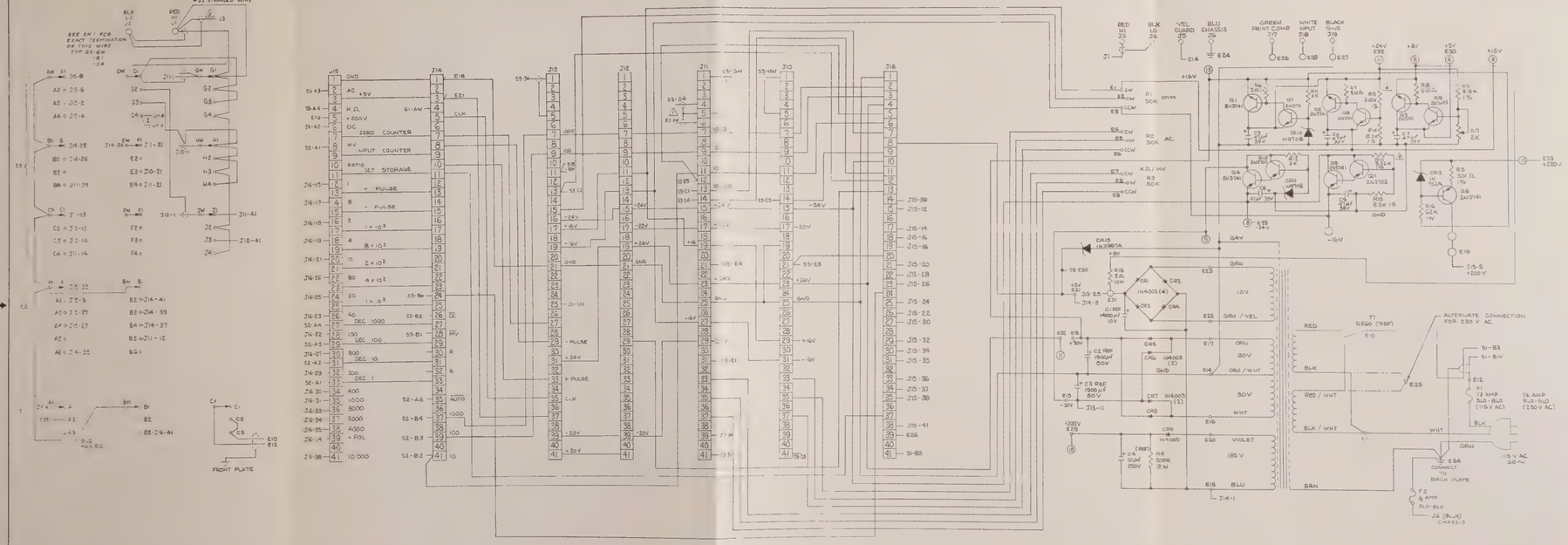
CONTR NO
DRAWN
CHECK
APPR
RELEASE DATE
MATERIAL

NLS NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY, AC/DC CONVERTER SCHEMATIC
SERIES X-2

SIZE D | CODE IDENT NO 03626 | 37-281
SCALE — | WEIGHT — | SHEET 2 of 2

37-281 SH2


#22 STRANDED WIRE
SEE SM-1 FOR EXACT TERMINATION OF THIS WIRE TYP 53-6W -61 -64
BLK LO J4
RED HI J3
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J14
J15
J16
GND
AC +5V
K Ω
+200 V
OC
ZERO COUNTER
MV
INPUT COUNTER
RATIO
SET STORAGE
1
+ PULSE
8
- PULSE
2 x 10³
1 x 10³
4 x 10²
2 x 10²
1 x 10²
40
DEC 1000
100
DEC 100
800
DEC 10
200
DEC 1
400
1000
8000
2000
4000
+ POL
10,000
-24V
+6V
+16V
-16V
+24V
-20V
+18V
+8V
+5V
+200V
+ PULSE
- PULSE
CLK
AUTO
FRONT PLATE
GREEN PRINT COMP 317
WHITE INPUT 318
BLACK GND 319
YEL GUARD 320
BLU CHASSIS 321
E24
+24V E32
+2V E31
+5V E30
+16V
E1 CW
E2 CCW
E3 CW
E4 CCW
E5
E6
E7 CW
E8 CCW
E9 CCW
R1 50K
R2 50K
AC
K Ω / MV
R3 50K
E33 24V
-16V
E19 +200V
J15-5 +200V
GAIN LM309K
+8V
TO E30
E18 3.3Ω 10W
+5V E41
J14-5
E31
1N4003(4)
CR1 CR2 CR3 CR4
C1 1800μF 10V
E32
+30V
C2 RES 1800μF 50V
E17
+30V
J15-11
C3 RES 1800μF 50V
E16
-30V
C46 1N4003 (2)
C47 1N4003 (2)
C48 1N4003
C4 50μF 250V
R4 220K 2W
GRN/WHT
VIOLET
BLU
J14-1
GRN/YEL
10V
30V
WHT
T1
D680 (REF)
E-0
RED
BLK
RED/WHT
BLK/WHT
WHT
BRN
ALTERNATE CONNECTION FOR 230 V AC
S1-B3
S1-B4
E12
F1
1/2 AMP SLO-BLO (115 V AC)
1/4 AMP SLO-BLO (230 V AC)
BLK
GRN
115 V AC 60 ~
E34 CONNECT TO BACK PLATE
F2 1/8 AMP SLO-BLO
J6 (BLUE) CHASSIS
Q1 2N3641
Q2 2N3704
Q3 2N3641
Q4 2N3704
Q5 2N3641
Q6 2N3641
Q7 2N3704
Q8 2N3641
CR10 IN3708
CR11 IN3708
CR12 IN752A
R5 50K 2L 1W
R6 6.2K 1W
R7 2K
R8 5.62K
R9 8.93K 1%
R10 2K
R11 5.62K
R12 6.04K 1%
R13 10K
R14 6.04K 1%
R15 5.62K
R16 8.2K 1%
R17 2K
R18 2K
R19 2K
GND
-24V
-20V
+24V
+16V
-16V
+18V
+8V
+5V
+200V
-24V
-20V
+24V
GND
+8V
-30V
+30V
-16V
-115V
+115V
+6V
-6V
+2V
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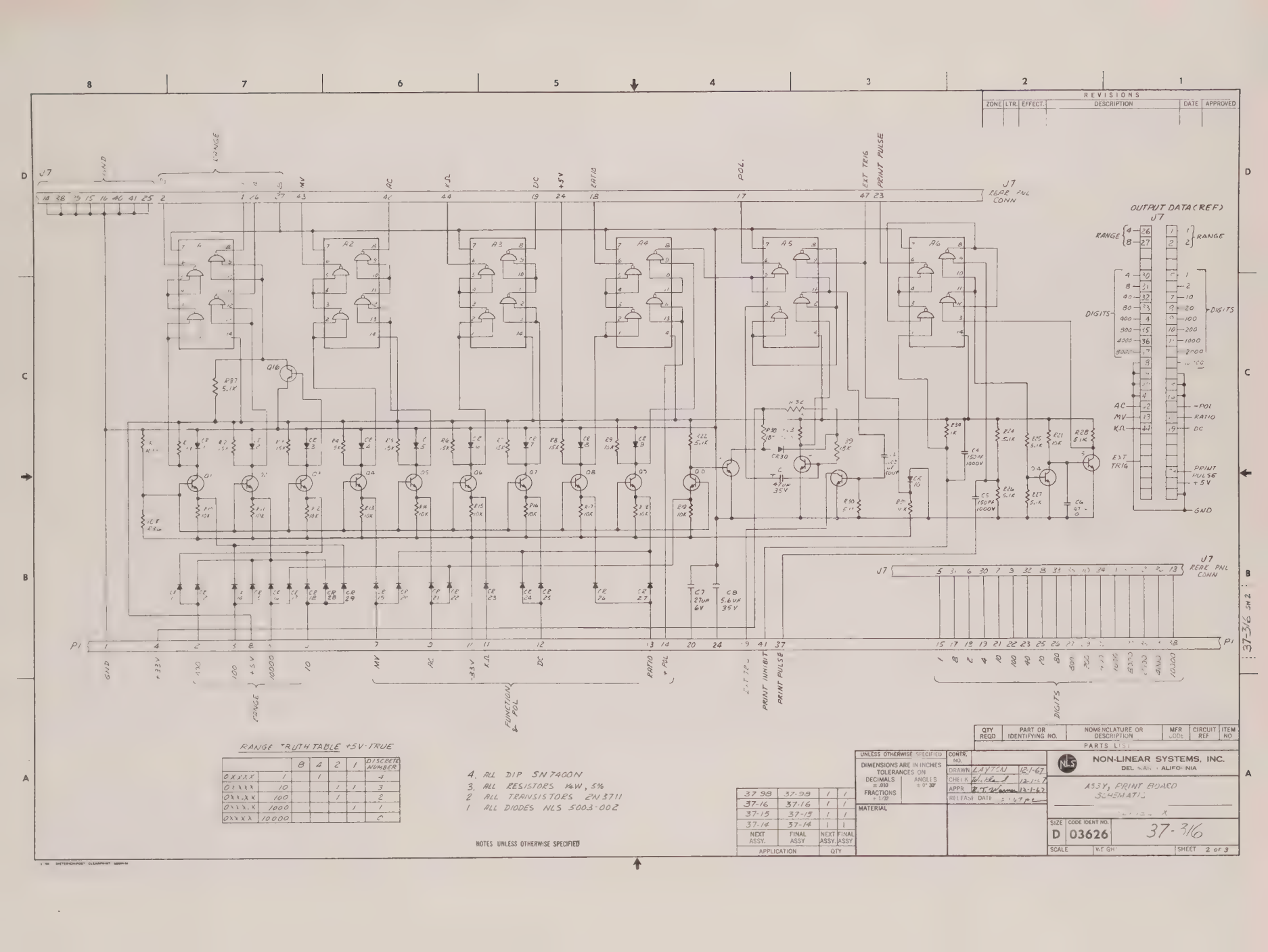
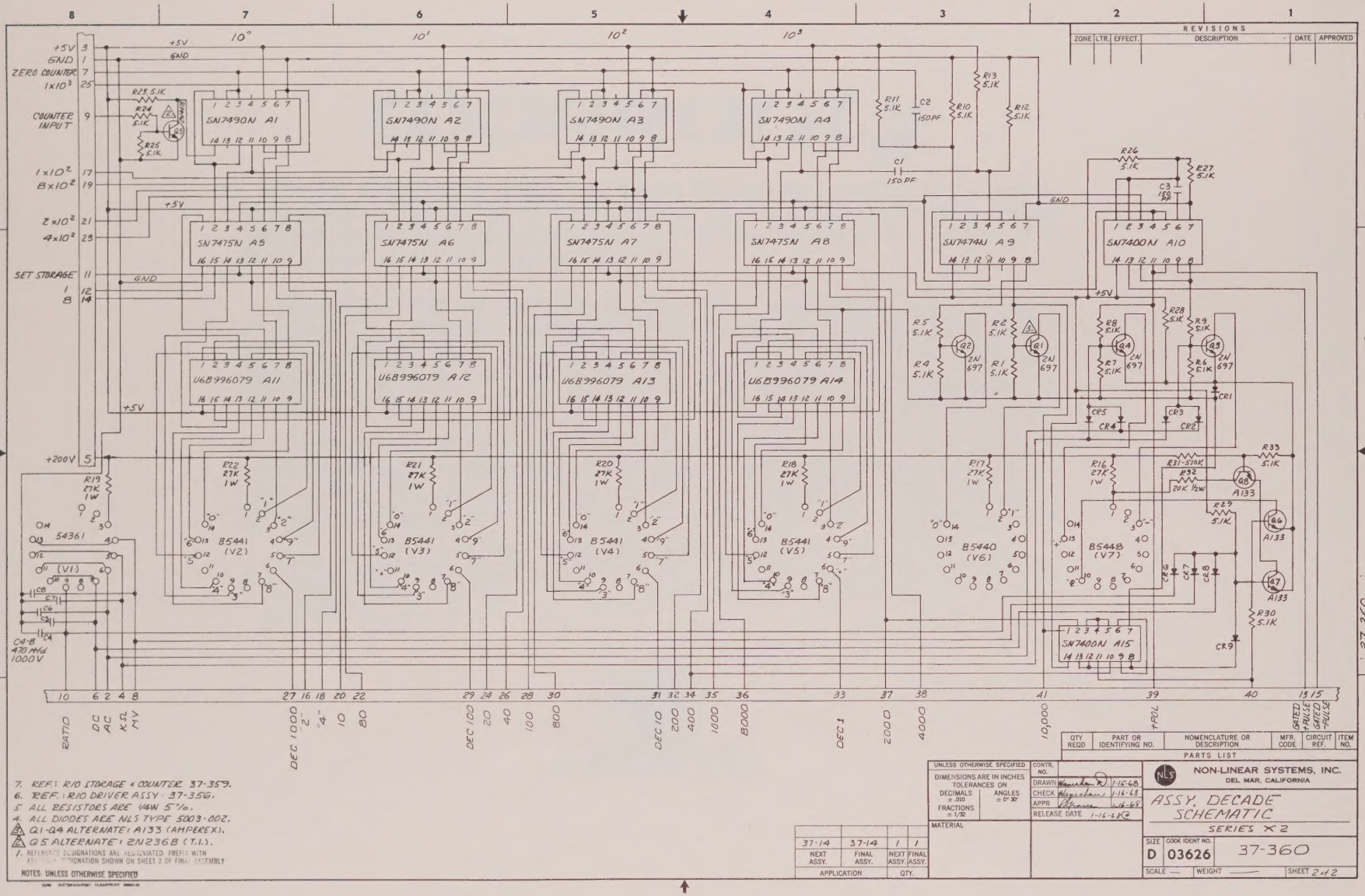

REVISIONS
ZONE | LTR. | EFFECT. | DESCRIPTION | DATE | APPROVED
J7
RANGE
MV
AC
K Ω
DC
+5V
RATIO
POL.
EXT TRIG
PRINT PULSE
J7 REAR PNL CONN
OUTPUT DATA (REF)
J7
RANGE
DIGITS
AC
MV
K Ω
EXT TRIG
-POL
RATIO
DC
PRINT PULSE +5V
GND
J7 REAR PNL CONN
P1
GND
+33V
.100
100
+5V
10000
10
MV
AC
-33V
KΩ
DC
RATIO
+POL
EXT TRIG
PRINT INHIBIT
PRINT PULSE
1
8
2
4
10
100
40
10
80
200
400
800
2000
4000
10000
RANGE
FUNCTION & POL
DIGITS
RANGE TRUTH TABLE +5V TRUE
B 4 2 1 DISCRETE NUMBER
0XXXX 1 4
01XXX 10 3
001XX 100 2
0001X 1000 1
00000 10000 0
NOTES UNLESS OTHERWISE SPECIFIED
4. ALL DIP SN7400N
3. ALL RESISTORS ¼W, 5%
2 ALL TRANSISTORS 2N3711
1 ALL DIODES NLS 5003-002
37-98 37-98 1 1
37-16 37-16 1 1
37-15 37-15 1 1
37-14 37-14 1 1
NEXT ASSY. FINAL ASSY. NEXT ASSY. FINAL ASSY.
APPLICATION QTY
QTY REQD | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MFR CODE | CIRCUIT REF | ITEM NO
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
ANGLES ±0° 30'
FRACTIONS ±1/32
MATERIAL
CONTR. NO.
DRAWN LAYTON 12-1-67
CHECK 12-1-67
APPR. 12-1-67
RELEASE DATE
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
ASSY, PRINT BOARD SCHEMATIC
SIZE D
CODE IDENT NO. 03626
37-316
SCALE
WEIGHT
SHEET 2 of 3
37-316 SH 2



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

7. REF: R10 STORAGE & COUNTER 37-359.
6. REF: R10 DRIVER ASSY 37-356.
5. ALL RESISTORS ARE ¼W 5%.
4. ALL DIODES ARE NLS TYPE 5003-002.
3. Q1-Q4 ALTERNATE: A133 (AMPEREX).
2. Q5 ALTERNATE: 2N2368 (T.I.).
1. REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED	CONTR. NO.	
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .010 FRACTIONS ± 1/8 ANGLES ± 0° 30'	DRAWN	1-15-68
	CHECK	1-16-68
	APPR	1-16-68
	RELEASE DATE	1-16-68
MATERIAL		

37-14	37-14	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY. DECADE SCHEMATIC
SERIES X2

SIZE	CODE IDENT NO.	
D	03626	37-360
SCALE —	WEIGHT —	SHEET 2 of 2

non linear
systems, inc.

DEL MAR, CALIFORNIA